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THE SCRAP HEAP.

An interesting note appeared in our columns not long since to the effect that some Jablochkoff lamps had just gone out of service in Calcutta, India, after being in use over twenty years. We doubt whether this record could be equalled in this country for lamps, whether of the make in question or any other. The Jablochkoff lamps in this country had a brief although not particularly inglorious career, and this Calcutta episode is but another proof of the reluctance of our British and European friends to compile a scrap heap as sedulously as we do.

The relative life of electrical apparatus is a subject that is not much discussed, although we fancy there is a great deal of apparatus in service which is still giving a good account of itself after prolonged years of operation. Many of the early street railway motors are in use, we believe, and one frequently encounters primeval lighting apparatus. It does not follow that a plant is "scrapped" when it is exchanged for one of later date, and in fact, our advertising pages frequently give evidence to the healthy and active state of the second-hand market. A curious exemplification of the rage for change may be found in the lawsuit recently settled in favor of the Electric Light Company at Davenport, Iowa, which, after using its direct-current plant for two or three years, was ordered on pain of cancellation of its franchise by the city council, to change over to the alternating current. The courts have now sustained it in its refusal to scrap its apparatus in such a hurry, but there is no doubt that the rapid advance of the art very often brings about, without suspicious compulsion like that just referred to, radical changes in electrical apparatus of all kinds. In fact, it may be questioned whether the life of a telegraph or telephone system is much longer than that of a lighting and railway plant, with the proviso that when the apparatus is scrapped this does not always mean that it is broken up or altogether loses its functions of utility. It is an interesting commentary upon the way in which old material can be worked up that a steel plant at Hamilton, Ont., makes the claim that it has worked over into new material the iron of the original Niagara Suspension Bridge, the iron of the original Victoria Tubular Bridge at Montreal, the hull of the famous old Atlantic liner, the *City of Rome*, and the iron framework of the famous steamship the *Great Eastern*. In like manner, much electrical apparatus is living again to-day in forms that sometimes would hardly be recognized by those who used it when it was first brought out many years ago. We have seen lately some "long-waisted" Edison dynamos that certainly go back to the beginnings of the incandescent art, and we are told that the original Siemens & Halske electric road material, shown at Paris in 1881, is still earning a humble livelihood on the banks of Lake Leman, somewhere in the vicinity of Chillon.

DESIGN OF INDUCTION MOTORS.

Elsewhere we print an article by Mr. Hobart on the design of induction motors, which in a sense is a continuation of his article on the choice of the rotor diameter which we printed in our issue of January 23 of this year. The papers of Messrs. Parshall and Hobart on the design of electric generators for direct current, which appeared several years ago in the English engineering press, showed the critical judgment of these distinguished engineers in the application of formulas and theories to the design of direct-current machines. Intimately connected with the method of calculation of the inductance of the coils under commutation in direct-current gen-

erators is Mr. Hobart's correction and amplification of Behrend's well-known formula for the dispersion coefficient, upon which are based the circle diagram, and, with it, the theory of calculation of motors and generators embodying the induction principle.

The working of an induction motor or of an induction generator depends, according to Behrend's theory, primarily on two factors: First, the current which the motor takes while running at synchronous speed; and, second, the current which the motor takes while standing still. These two magnitudes determine the characteristics, such as power factor, torque and slip, of the induction machine, acting either as generator or as motor. The determination of the no-load or magnetizing current is a comparatively simple matter, as it involves only the calculation of the line integral of magnetizing force for the magnetic circuit of the motor, and requiring no constants of leakage or dispersion. This, however, does not apply in regard to the calculation of the current at standstill, the magnitude of which depends altogether upon the leakage and dispersion of the motor. The theory of the induction machine shows that the magnetizing current and the current at standstill are connected by a simple mathematical relation containing a factor which we term by courtesy a "constant," dependent upon the design of the slots, the air-gap, the pole pitch, and the length of the core. Behrend maintains that the constant depends "upon a great many other conditions of which we are still profoundly ignorant," and it is Mr. Hobart's aim to throw light upon this question.

Mr. Hobart's results may be summarized by saying that he shows the dependence of the factor in Behrend's formula on the ratio of the length of the core to the pole pitch, the factor being smaller the greater this ratio, proving the accuracy of his curves by tests on a large number of induction motors. A critical contribution to the literature of designing is most valuable by fixing ideas and dispelling hazy and incorrect notions which lead to superficial judgment and sham knowledge. From the judgment of fact there is no appeal, and we are all indebted to Mr. Hobart for his laborious tables and data to check the assumption of theory.

THE DIFFERENTIAL TELEPHONE.

The last number of the *Physical Review* contains an interesting article by Messrs. Duane and Lory on the differential telephone. Of course, differential telephones have been used for many years in alternating-current laboratories, so that there is no novelty in the instrument itself; but the directions given, in the article, for adjusting the instrument, enable it to attain a much higher standard of sensibility and measurement than would otherwise be possible. In order that a differential telephone may be capable of giving accurate results, it must be wound with mechanical symmetry, the magnetizing actions of the two windings must be well nigh identical, the resistances of the two windings must be almost exactly equal, and their inductances must also be almost exactly equal. To effect these equalities is by no means so easy as it sounds, either verbally or telephonically. The writers claim, for a carefully adjusted differential telephone, a theoretically attainable degree of accuracy, under laboratory conditions, of one-hundredth of one per cent., in the measurement of small ironless inductances, and a practically attainable degree of accuracy of one-twentieth of one per cent., or less. It is very desirable that a research should be made with such an instrument upon the resistivity of electrolytic solutions, with different frequencies of alternating current, throughout a wide range, in order to ascertain what effect, if any, is exerted by the frequency, upon the measurements. It has been asserted that the frequency may have a very appreciable effect, but we know of no measurements yet forthcoming to demonstrate the fact.

ZOSSEN STEAM TRIALS.

The daily papers are printing dispatches of renewed tests on the now famous Zossen line, this time with steam locomotives of weird and fanciful design intended to show to all the world how the best traditions of German express service can be preserved in spite of the threatened irruption of electric motors. Full details of the slow degrees by which the speed was raised to limits hitherto unknown on German government railways are not yet forthcoming, but we presume the earlier trials to stiffen the nerves of the daring experimenters were on hand cars driven by brawny Teutons goaded to desperation by the knowledge that the nearest available beer was at Marienfelde. Be that as it may, a few days ago trial was made of a mighty locomotive weighing with its tender 85 whole tons and using superheated steam and lubricating oil in apparently about equal proportions. To this space-devouring and time-annihilating monster were hitched three German cars and with a loaf of schwartzbrodt chained to the safety valve, and the terrified officials stretched on the floors of the cars hanging on with hands and teeth to keep from rolling off, the whole outfit hurtled through the shuddering atmosphere at 84½ miles per hour! We have searched literature from the time of Cadmus on for a suitable pæan of triumph with which to celebrate this epoch-making achievement, but the only one which seems to fit the case is a sonorous classical fragment in which a mountain and a mouse are the principal figures. O, mighty prophetic soul of Æsop, how hast thy wisdom shone through the mists of centuries to illumine this latest victory of mankind!

The addition of three more cars pulled down and speed of this leviathan of the rails to a scant 80 miles per hour, and we hesitate to imagine what would have been the result of adding still three more. To our benighted American eyes the whole loudly heralded performance looks like M. 1.20. Hardly a summer day passes in which one of the regular trains between New York and Philadelphia does not run off miles in 45 seconds or thereabouts, and there is one record on the Lehigh Valley Railroad of more than 40 consecutive miles run at the rate of 80 miles per hour. There is, too, a run on the Burlington route of 14.8 miles in just 9 minutes—98.7 miles per hour, and of single miles in less than 40 seconds there have been too many to keep account of. And all this has been done without any fuss and feathers by standard express locomotives, for the most part drawing regular trains. There has been no solemn posing about it—a train chanced to be a bit late and the engineer, with a clear track ahead, has merely shaken out a few kinks and arrived on schedule time. In the trials of regular German express engines over the Zossen course none of them is reported as having touched 80 miles per hour even with a three-car train, much less with one of ordinary length. These trials may be amusing to the officials who draw up elaborately sealed reports upon them, and may be more or less interesting to the engine builders; but as demonstrations of the capabilities of steam locomotives they are about as convincing as a press report from Che-Foo. If the Boss of the German railway system (we forget his polysyllabic official title) really wants to chase a few speed records, he had better import a Yankee track boss and a few of our standard engines and get down to business. They can show him more about making time in a week than he will learn at Zossen in a month of Sundays. We have the highest respect for German engineering skill in general, but in the steam railway business it seems to be hopelessly behind the game just at present. And if America as a school of instruction is too distant our Teutonic friends might organize a secret service to pry into the details of the express service of their Gallic neighbors, who in railroading vastly outrank other continental countries, and can give us also a run for our money.

As a mere feat in railroading it is not a difficult matter under favorable conditions to make one or a few miles at a speed of 100

miles per hour or thereabouts. But so long as the locomotive has to be burdened by carrying its own fuel and water and carrying also a large dead weight not directly concerned with power production, its power of sustained high speed is necessarily limited. The strong point of the electric locomotive is that it is not compelled to carry its power station upon its back, but can utilize nearly the full weight necessary for adhesion to the rails for available driving power. Nor is it forced to slow down for taking on fuel or to scoop up water, or to get the fire in condition. It can attend strictly to the business of pulling, first, last and all the time. It can hold the same speed for a long run as for a short one, so long as the track is in good condition. The difficulty with greatly increased running speeds is not in the electrical part of the equipment, but with the track; and more than all else, with the commercial demand for high speed. Conditions of equipment being the same, there is more profit in moderate speed than in very high speed, and so long as there is only nominal competition between railroads there will be no radical improvements in speed. It is only in long runs that very high-speed trains show to the best advantage, which is another obstacle, since the equipment of five hundred or a thousand miles of track for hundred-mile-an-hour work means a very large investment, right of way difficult to be obtained, the abolition of all grade crossings, and fierce opposition from the existing lines threatened. Some day a horoscope favorable in all these points can be cast and then the thing will be accomplished. It is strictly an electrical job, however, and the continuance of these trials at Zossen will only serve to emphasize the fact. They display admirable zeal, but they lead up a blind alley.

The Measurement of Stray Power by Calorimetry.

In the operation of water-cooled transformers, the power wasted in the iron and copper may be determined both electrically and thermally. In fact, while the electric method is commonly regarded as the simpler and more reliable, the thermal method is often employed in addition, as a check. All that requires to be done is to turn on a steady stream of cooling water, and, after a sufficient lapse of time for arriving at a substantially steady thermal condition, to measure the rate of flow of water, together with the difference of temperature between the incoming and outgoing stream. This heat delivery, expressed in watts, corresponds to the power wasted in the transformer. In a paper by Prof. Threlfall, appearing in the last number of the *Journal* of the Institution of Electrical Engineers (London), the same method is described as applied to tests of alternators running in air, the heat delivery in this case being measured in the flow of air circulated by a ventilating fan. A light housing is built over and around the alternator to be tested, so as to enclose the stream of ventilating air. A steady load is applied to the alternator, the power being delivered by the shaft passing through the wall of the housing. After a sufficient lapse of time, depending upon the size of the machine, the rate of flow of air driven through the system is measured, as well as the difference of temperature between the incoming and outgoing air. The flow of heat thus determined, as expressed in watts, measures the power wasted electrically in the copper and iron of the alternator; also the power wasted in windage friction, as well as a considerable part of that expended in bearing friction.

Much more care has to be taken in the measurement of the rate of air-flow in this test than in the rate of water-flow in the corresponding test of water-cooled apparatus, partly because air is a readily compressible fluid, and partly because its thermal capacity is much less than that of water. It takes about 4 joules to raise a gram of water 1° C. (more nearly 4.18). It takes about 1 joule to raise a gram of air 1° C. (0.993 joule). Consequently, by mass, air has only one-quarter of the thermal capacity of water. Moreover, since a gram of dry air at standard temperature and pressure occupies approximately 773 c.c., 1 c.c. of standard air only carries off 1/773 joule in rising 1° C. Consequently, by volume, standard water has about 3,250 times the thermal capacity of standard air, and 3,250 times more volume of standard air must be sent through an apparatus to carry off the heat for a given temperature elevation, than in the corresponding case with water.

The rate of flow of water cooling a large transformer is usually only a few cubic centimeters per second; but the rate of flow of air supplied by a ventilating fan to an alternator of moderate size, in these tests, is measured in cubic meters per second. In order to measure the rate of flow of air through a delivery pipe 21 in. in internal diameter, a Pitot tube was used. This is a well-known simple form of pressure gauge, consisting of a small cup supported in the delivery pipe so as to face the air-stream, and having a small tube leading from the bottom of the cup to a pressure gauge outside. It is shown very interestingly in the paper that with proper precautions, the pressure indications of a Pitot tube are capable of determining with considerable accuracy the velocity of the air-stream in the neighborhood. The effect of friction at the walls of the delivery pipe materially reduces the velocity of air-flow at and near the walls. A correction of about 6½ per cent. has to be made for this effect on the velocity of flow as measured at the center of the pipe. Corrections have also to be made for barometer, hygrometer and mean temperature of the air. It is claimed, however, that after all corrections are made, the method is capable of measuring power losses within a few per cent., and efficiencies within a fraction of one per cent. The advantage of the method seems to be that the apparatus required is comparatively inexpensive, and that it may be employed when no other measure of frictional losses is available. The disadvantages of the method are that it requires a special housing to be built over the machine to be tested, that the load must be kept steadily applied to the machine for several hours, and that many corrections have to be taken into account in the computations.

It does not seem likely, therefore, that this method of testing will come into general use. The ordinary electrical methods for measuring stray losss are so much simpler and swifter that there is no comparison between them and the calorimetric method. It is true that some of the assumptions involved in these electrical stray-loss methods are open to dispute, in regard to accuracy under full-load conditions. Nevertheless, if machines are specified to possess a certain efficiency, when tested by the electrical stray-loss method, the results are at least, comparable with those of other machines tested in like manner. The main value of the paper seems not merely to reside in the working out of a feasible method of measuring the efficiency of alternators, but also in supplying much valuable information concerning the flow of air through straight tubes. It is well known that this is a subject on which much difference of opinion exists, and where empiricism is rampant. In showing how to obtain accurate results from a Pitot tube, the author has contributed much to this subject, quite independently of other considerations. This is one more instance of the indebtedness of engineering to physics. In the discussion on the paper, the theory of the Pitot tube was developed very clearly, showing that the velocity near the cup was the square root of twice the density times the difference of pressure between that at bottom of the cup and at the side walls of the flue. It was also shown why the cup must have thin edges and squarely face the direction of flow; while the pressure at the walls must be found with a very flat-mouthed exit tube.

The Union Engineering Building.

The preliminary work of the Conference Committee on the Union Engineering Building was closed last week after a considerable amount of labor on the part of all interested, and the programme of competition will be placed in the hands of architects during the present week. In this work the committee has enjoyed the advice of Prof. W. R. Ware as professional adviser, and it is needless to say that the programme has been drawn with great care. The plans submitted in the competition by the selected architects and by those who enter the open competition are to be in the hands of Prof. F. R. Hutton, secretary of the committee, by June 15, and it is expected shortly thereafter to arrive at a decision as to the preferable plan. The Engineering Building on Thirty-ninth Street, about midway on the north side of the block, will occupy about 10,500 square feet, exclusive of the 15 feet open space reserved under the city ordinances, the outside dimensions of the land being about 125 feet by 100 feet. To the east of the building Mr. Carnegie has bought and reserved a residence which will be maintained at its present elevation so as to protect the air and light of the building on that side. The general plans of the building have already been outlined in these columns, but it may be stated that there will be at the top of the building three stories held for the use of technical societies invited to participate in the benefits of the building. Three other similar floors will be reserved, one each for the American Institute of Electrical Engineers, the American Institute of Mining Engineers and the American Society of Mechanical Engineers. These floors will make ample provision for offices and each will have a large, handsome reception room as well as board and committee rooms. Below these will come the library, virtually a double floor; although the committee will entertain plans placing the library at the top of the building. Next below will come a large main auditorium floor, which will seat from 1,200 to 1,500 people, with 1,000 on the floor and about half as many additional in the galleries. This floor will preferably be as near the sidewalk as possible, and may have above it or below it a number of smaller meeting rooms having similar purposes, seating audiences of from 500 down to 100. There will be six such rooms and these as well as the large room will all be thoroughly equipped with gas, compressed air, steam, water, electricity, etc., for the conduct of experiments and demonstrations. There will also be lounging and smoking rooms, and provision will also be made for special banquets by outside caterers and the serving of occasional collations. The floor on the street level will be appropriated mainly to administrative purposes with three coat rooms capable of taking care of 1,500 garments at once, a ladies' dressing-room, a bureau of information, public telephone and telegraph offices, the post-office and sales department and shipping and receiving offices for books, publications, etc. Below this floor, from which probably a fine stairway will lead to the auditorium above, will come the basement and sub-basement, with provision for storage purposes, machinery, coal and operative apparatus. There will be three elevators in the building of large capacity, one being able to take care of freight. The library floor will be laid out so as to accommodate not only the present consolidated libraries of 50,000 volumes, but a well-rounded comprehensive collection of six or eight times that num There will also be a number of reading and reference rooms on that floor. For the purposes of the Engineering Building and the Engineers' Club regarded as separate structures, it is proposed to expend about $1,000,000, leaving the other $500,000 for tearing down old buildings, excavation, architects' and engineers' fees, machinery, elevators, lighting fixtures and the equipment of the library and auditorium. As to the architecture of both buildings, it is the expressed wish of Mr. Carnegie that it should be simple and dignified, something that will be as good in style a hundred years from to-day as now.

The Engineers' Club, with a frontage of 50 feet and a depth of 100, will front on Fortieth Street and Bryant Park, looking across to the New York Public Library, now partially completed. It is proposed that the club building shall be eleven and a half stories, including also basement and sub-basement, but differing, of course, in all other respects from its near neighbor. The half story will be on the roof and will have the kitchen and some rooms for accommodation of the help, the other part constituting a roof garden with outlook on the little park and Hudson River. The eleventh floor below will be occupied entirely by the main dining-room or banquet hall and its service facilities, and will be one of the finest rooms in the house, looking across to the Park and New York Library. Below this will come the breakfast room floor with a large breakfast and lunch room and several private dining-rooms. Next will come four floors, occupied by bedrooms for members. There will be sixty of these rooms in all and the smallest is to be not less than 150 square feet. There will be generous bath facilities and all rooms will have outside air and light. Below these sleeping accommodations will come the billiard room floor, with a large billiard room across the front of the house and with board rooms, committee rooms, card rooms, etc., in the rear. Next below will come the floor containing the club room or general reception and meeting-room in front and the library in the rear, these being the only two rooms on that floor. The next or ground floor, raised several feet above the sidewalk, will contain the office, large coat rooms, general reception rooms, telephone booths and a large, handsome café. Below the sidewalk will be a basement and sub-basement containing machinery, refrigerating plant, store rooms, wine cellar, steward's rooms and sundry other facilities. There will be three elevators running from cellar to roof, one with capacity for freight. There will also be a main grand ornamental stairway running up to the level of the billiard room floor and there will be service stairways throughout, which can also be used by the members. It is believed that good architectural plans will enable the buildings to present from the Bryant Park front a harmonious and handsome ensemble above the roofs of the private dwellings in the vicinity. A covered areaway across the light well between the two buildings will render intercommunication easy and the committee will also entertain plans throwing a light, artistic bridge across at about the level of the library floor of the Engineering Building.

The six architects selected for the mixed competition have already been named in these columns, and this week the printed programme will be placed in their hands and will also be available for other architects in good standing, many of whom wish to come into the open competition. The selected architects are each to receive $1,000, which is to be charged against the commissions in case of success. The competitors on the open list have the encouragement of four equal prizes of $200 each for the four best designs. The date for the filing of the competitive plans is June 15. The committee hopes to be able thereafter to make a prompt decision and will proceed with the prosecution of the work without delay.

The three societies have been requested recently to appoint members to serve on a special committee which shall at once take the work in hand of unifying and harmonizing the methods of their various libraries, so that when the collections are brought together, they will be ready for co-operative administration.

Telegraphers in the Civil War.

As is well-known, the United States Corps of Military Telegraphers after many years of work, has at last succeeded in securing recognition of the services of the men who worked the key at the front in the Civil War. In a report favoring the extension of pension privilege to the operators who thus served the government, Senator Scott, of West Virginia, has related some interesting incidents of the service which enabled the armies and parts of armies to keep in communication with each other, and which enabled President Lincoln to be in touch with all his generals. Throughout the war there were, all told, 15,000 miles of wire operated by the army telegraphers, and the service cost the government about $3,000,000. Twelve hundred operators were employed.

During the operations in front of Atlanta, in 1864, twenty miles of wire was kept in operation twenty-eight days by almost as many operators, half of whom were exposed to the enemy's fire while at work at their instruments. At New Orleans, says the report, the operators and linemen were not only in danger of being shot, but risked their lives almost daily in the surf in trying to keep the submarine part of their system in working order. The active service of the operators practically came to an end when they rushed a line of wire to Appomattox, over which the news of Lee's surrender was received at Washington within two hours after the event.

President Wilson, of the Society of the United States Military Corps, says of the military telegraphers of the Civil War: "The list of casualties and captures in this little corps, probably aggregating 322, establishes its military character. The 15,389 miles of military telegraph lines constructed and operated in the threatres of the war by this corps, hundreds of whom were within range of the enemy's guns and often under fire, evidences a devotion and bravery that surely make its members worthy of comradeship with others of the army."

The Plant of the Kansas City Home Telephone Company.

By Max Loewenthal, E.E.

THE marvelous development of the electrical industries throughout the United States during the past decade contains no record that can excel the growth of the independent telephone movement. The latest statistics show that of the 212 cities in the United States having more than 20,000 inhabitants, 162 already have independent telephone exchanges, franchises have been granted in 11 additional and applications are pending for franchises in 12 more. There are at present in operation in the United States over 6,000 independent telephone exchanges which operate in round numbers 2,000,000 telephones in exchange service, representing an investment of over $200,000,000. It is interesting to note in this connection that only 4 per cent. of the population of this country are using telephones, while in some sections it is being used by from 12 to 15 per cent. of the population and even more. The education of the general public to the use of the telephone as a convenience has developed its use to an absolute necessity. The independent telephone development in Missouri and Kansas has been so rapid and popular that there are to-day twenty telephones in operation where there was one at the beginning of the movement. All of the independent exchanges in this territory are being rapidly connected by long-distance service.

One of the most perfect types of the modern telephone system is that which has just been completed by the Kansas City Home Telephone Company, in Kansas City, Mo., and Kansas City, Kan., this system having immediate facilities for taking care of 8,200 subscribers, and an ultimate capacity of 34,000. The system will have in operation before the end of the year 1904 about 8,500 private line telephones and has now in successful operation about 6,000 lines, installing new telephones at the rate of twenty a day.

The Kansas City Home Telephone Company was incorporated in November with a capital of $50,000, which was increased in January, 1903, to $3,000,000, of which $1,700,000 have been issued. The balance of the stock and bonds, there being a bonded indebtedness of $1,700,000, is in the treasury for future extensions and betterments. The company operates under a thirty-year franchise

FIG. 1.—MAIN EXCHANGE BUILDING, KANSAS CITY, MO.

in Kansas City, Mo., and a twenty-year franchise in Kansas City, Kan., the two cities having a combined population of about 300,000.

The movement which led to the organization of this company was started about two years ago. The franchise which was originally granted to John Enoch was purchased by the Central Telephone Construction Company, of Toledo, Ohio, which constructed the entire plant. The officers of this company are Ed. L. Barber, president; O. C. Snider, secretary and treasurer, and James S. Brailey, Jr., manager. Through the efforts of this company the enterprise was financed by the organization of an underwriting syndicate, managed by the Germania Trust Company, of St. Louis, now a part of the Commonwealth Trust Company. The construction company also had entire charge of the canvass for subscribers and secured 9,000 three-year contracts with comparatively little effort.

Actual work was started in the fall of 1902. Multiple-duct con-

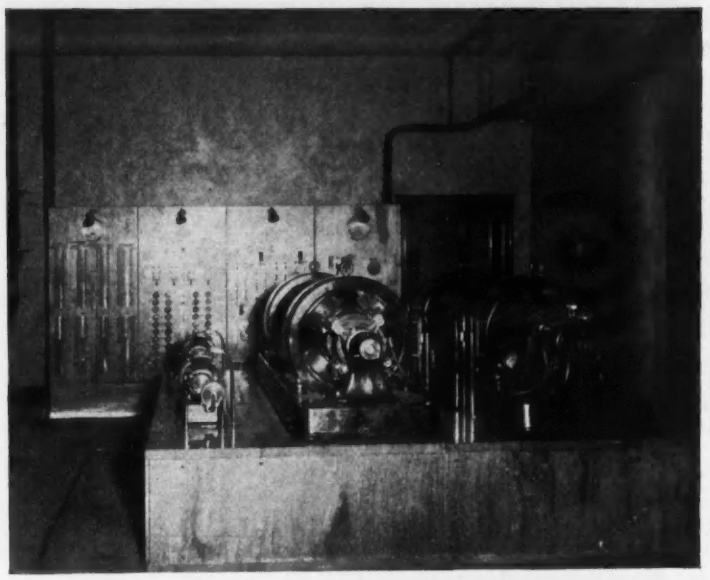


FIG. 2.—POWER PLANT, MAIN EXCHANGE.

duits were laid throughout the entire business section and the company owns at present 750,000 duct-feet of conduit and 260 manholes. All-copper overhead construction has been adopted throughout the residence districts and local distributing poles are located in the alleys throughout the city. So as to distribute efficiently the load on the system it was decided to build one main and three branch exchanges, each serving the section within which it is located. The main exchange building, shown in Fig. 1, is a handsome three-story and basement brick building, with terra cotta trimmings, and is located on Baltimore Avenue, in the very heart of the business district of Kansas City. It is 120 ft. in length and has a frontage of 60 ft., while its width in the rear is but 44 ft., about 8 ft. having been cut off on each side so as to insure ample air and light shafts,

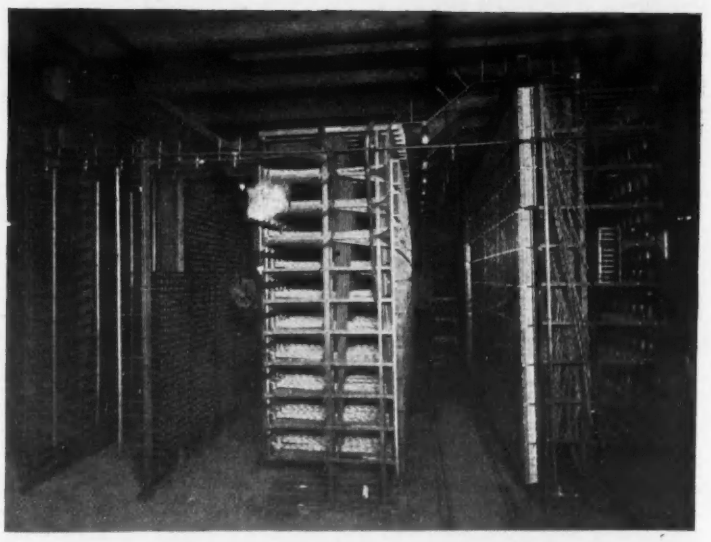


FIG. 3.—MAIN, INTERMEDIATE AND RELAY RACKS, MAIN EXCHANGE.

should buildings be erected on either side of the exchange. The 37 lead-covered cables, each consisting of 200 pairs of No. 19 gauge Roebling dry-core paper-covered wires, enter the building in the basement, where they have been spliced to twice the number of 100-pair cables, which run to the main distributing frame on the floor above.

In the basement also are located the repair and carpenter shops,

benches, lockers and toilets for the outside men, hot water and steam combination boiler and the material room.

On the second floor are the power and distributing frame room, the long-distance tollboard, the kitchen, dining-room, toilets and lockers for the operators. The power plant, shown in Fig. 2, consists of a duplicate set of motor-generators of the Holtzer-Cabot type, for charging purposes, the motor end receiving 114 amp. at 220 volts at a speed of 1,000 r.p.m and the dynamo generating 300 amp. at 60 volts. As there is a duplicate set of batteries, the charging machines are so connected through the switchboard that either set of batteries may be charged by either machine, and the machines are so wound that the batteries may be charged while furnishing current for the exchange without creating noise in any of the talking circuits. They are of sufficient size for the ultimate capacity of the exchange.

The ringing machines, made by Roth Bros. & Co., are equipped with a device for the "busy back" signal for the trunking positions, and for signalling to any subscriber who may have left his receiver off the hook. The generators each have a sufficient output to operate the entire capacity of the switchboard.

The power switchboard, also seen in Fig. 2, consists of four panels, known as the fuse, ringing and two power panels. The board is of Tennessee marble, is 12 ft. long and 8 ft. high. The power panels are provided with Weston voltmeters and ammeters and necessary switches for connecting either machine to the battery or for charging the battery and feed current to the switchboard. Automatic circuit-breakers prevent the current from flowing back from the storage batteries to the generators. The voltage of each individual cell may be read on a special low-reading voltmeter. All circuits leading from the power board are individually fused on the face of the board.

Toward the front of the building in the same room are the main and intermediate distributing and relay racks, shown in Fig. 3. The main racks are built up of structural iron and so braced as to be rigid and substantial. The main rack is provided with terminal

FIG. 4.—BATTERY PLANT IN MAIN EXCHANGE.

clips mounted on hard rubber and is arranged at present for 5,500 lines, but is so designed that it can be extended from time to time until the ultimate capacity of the exchange is reached. It affords the best facilities for the placing and removal of jumper wires.

The intermediate distributing rack, similar in construction to the main rack, is so arranged that any line may be connected to any operator's position without changing the number of the outside line, or the multiple jack. Adjoining this rack is the relay frame on which the line relays are mounted. Sufficient room has been left between the frames and the power plant to provide for the extension of the racks to such an extent as to permit of an ultimate room capacity of 12,000 subscribers.

The duplicate set of batteries is located in a room back of the power board. These batteries (Fig. 4) furnish all the current required for the operation of the exchange and are of sufficient capacity to operate the plant without recharging for 48 hours. Each set of batteries consists of 20 cells and the plates in each cell are placed in lead-lined tanks of such size that additional plates can be added until there are a sufficient number to operate the ultimate capacity of the exchange for 36 hours without recharging the cells.

In close proximity to the power plant is the desk of the wire chief. It is arranged for two positions and each position is equipped with 10 complete cord circuits with listening and ringing keys and 10 order wire keys. Space is provided in each position for an ultimate capacity of 40 line lamps and jacks, the present equipment being for 30 lines, operating automatically on lines leading, one to the monitor's and chief operator's desk, one to the trouble clerk and six to the strip of multiple jacks in the main board. Five jacks terminate in cords and plugs in the keyboard of what is known as the eleventh

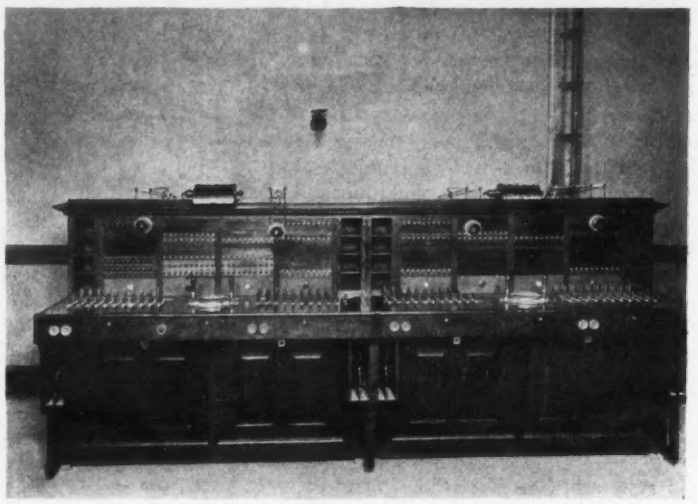


FIG. 5.—LONG-DISTANCE SWITCHBOARD, MAIN EXCHANGE.

and twelfth positions, two in cords and plugs at one of the trunking positions in branch exchange A, two in B and two similarly in branch C. There are five two-way leads which lead to the distributing frames in the various exchanges. All lines are duplicated in the two positions, so that they may be answered or tests made from either or both positions. A double-scale Weston voltmeter is situated between the two positions. All circuits are so arranged and designed that by manipulating the keys all required tests for "opens," grounds, reserves, shorts and all other trouble, both on the line and on the switchboard, can be made from this desk. The desk is also equipped with a key and special apparatus for signalling a subscriber when his receiver is left off the hook. A large number of pigeon-holes for trouble tickets are also provided. In a room adjoining the one described above the long-distance switchboard is located. This board, shown in Fig. 5, is designed for four positions and at present has a 30-line equipment. It is provided with modern incoming and outgoing trunking facilities for the rapid handling of service. The board is equipped with standard calculagraphs for the timing and checking of messages.

On this floor also, separated from the mechanical department by the main hall, is the dining-room for the operators, the kitchen, etc., and the offices of the superintendent of equipment. The main operating room, shown in Fig. 6, is situated on the top floor of the building and embodies every feature tending to mechanical and sanitary perfection. Plenty of light is insured by a large number of windows and artistic skylights, while forced circulation keeps the air pure, a 30-in. ventilating fan pulling the vitiated air out at the floor line.

The full common battery multiple switchboard consists of 19 sections of three operators' positions each. It has a present equipment of 5,500 lines with 160 outgoing trunk lines and 20 desk lines, also 150 incoming trunk lines and 16 desk trunks. Provision has been made in the construction of the board for an ultimate capacity of 12,000 lines, 360 outgoing trunks and 20 desk lines in each section, and 140 answering jacks and lamps in each position. Each of the local, trunk and desk lines is multiplied throughout every section. Each position is equipped with 15 complete cord circuits with listening and ringing keys, supervisory and pilot lamps and a bank of ten order keys.

The framework of the switchboard is built of structural iron. The exposed cabinet work, including all cable boxing in the exchange room, is made of selected mahogany. The rear of the board is enclosed with hardwood doors, which are readily removable. Each operator's position is provided with two pilot lamps, with jeweled

caps mounted directly behind the cords and plugs, and just below the answering jacks. One lamp is provided with a white jewel and

FIG. 7.—EAST BRANCH EXCHANGE.

operates in circuit with the line lamp relay and remains lighted until the call is answered. The other lamp is provided with a red jewel and operates in circuit with the answering supervisory relay, and be operated when either lamp is lighted. All supervisory and line relays are capable of being operated by a telephone through 1,200 ohms line resistance and can withstand twice the normal pressure of the battery without sticking.

All circuits are strictly metallic and perfectly balanced under all operating conditions and arranged so as to produce no cross-talking or other inductive disturbances. In the center of the main operating room, which measures 90 x 40 ft., are the desks of the chief operator, the trouble and information clerks, and all within full view of the entire board.

To the one side of the operating room toward the front of the building is the emergency hospital, equipped with all modern medical appliances for the temporary treatment of operators who may

FIG. 8.—MAIN OPERATING ROOM, EAST BRANCH EXCHANGE.

be taken ill suddenly. To the other side is the operator's rest room, which is comfortably furnished and greatly relished by the operators during the two periods of rest of half an hour's duration. A well-

FIG. 6.—MAIN EXCHANGE OPERATING ROOM, KANSAS CITY, MO.

remains lighted until the connection is taken down, after the subscriber who originated the call has restored his receiver to the hook. Both pilot lamps are so connected that a night bell or buzzer may

known authority on the training of telephone operators (Mrs. H. Brown) is in charge of the operators, looking after their comfort and maintaining the strictest discipline, which is the foundation of

good service and success. On the first floor of the building are the various offices, auditing and engineering departments and the meeting room of the board of directors.

The three branch exchanges of the company are almost identical in construction and equipment, one of the buildings being shown in Fig. 7. Branch exchange A, known as the East office exchange, is located in the eastern residence portion of Kansas City, Mo. Figs. 8, 9 and 10 illustrate the equipment of this and the other branch exchanges. The east switchboard consists of seven sections of three

FIG. 9.—MAIN AND INTERMEDIATE DISTRIBUTING AND RELAY RACKS, EAST BRANCH EXCHANGE.

operators' positions each. It has a present equipment of 1,200 lines, with 120 desk lines, also 100 incoming trunk and 12 desk lines. Provision has been made for an ultimate capacity of 7,200 main lines.

Branch exchange B, known as the South office, is located in the southern residence portion of Kansas City, Mo. The switchboard in this exchange consists of five sections of three operators' positions each, and the present equipment consits of 700 lines, with 80 outgoing trunk and 20 desk lines and 75 incoming trunk lines and 9 desk trunks. Branch exchange C, known as the West office, is located in the business district of Kansas City, Kan. The board at this exchange is at present equipped for 800 lines with 60 out-

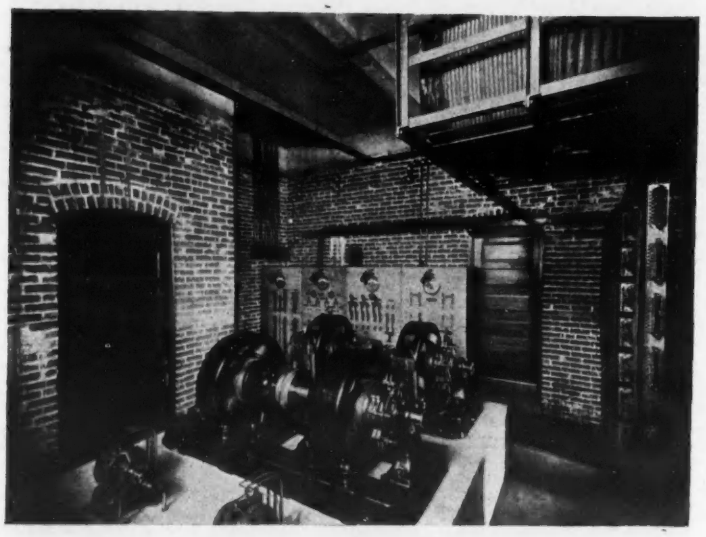


FIG. 10.—POWER PLANT, EAST BRANCH EXCHANGE.

going trunk and 20 desk lines and 75 incoming trunk lines and 9 desk trunks. The entire equipment of the exchanges was furnished by the Stromberg-Carlson Telephone Manufacturing Company, of Chicago and Rochester, and the plants were built by the Central Telephone Construction Company, of Toledo, under the personal supervision of the chief engineer of the Kansas City Home Telephone Company, Mr. W. C. Polk.

It may be of interest to note that the rates fixed by the ordinance in Kansas City, Mo., are $54 for business telephones and $36 for residence telephones, until January 1, 1907, when the company has the privilege of increasing the business rate to $60 per year. In Kansas City, Kan., the business rates are $54 and the residence rates $48 within a radius of 2½ miles from the business district, and the company is entitled to charge an additional $6 per mile per instrument for each additional mile or fraction thereof for extensions beyond this radius. The company has, however, adopted a uniform business rate in both cities of $54 and $36 for residence telephones, furnishing unlimited service between the two cities.

There are under construction and soon to be completed, long-distance lines reaching to Leavenworth and Atchison, Kan., and St. Joseph, Lexington and Sedalia, Mo. These lines will reach all independent telephone systems in their territory, and at their terminals connect with other lines reaching all over the States of Kansas, Missouri, Iowa, Illinois, Indiana, Kentucky, Indian Territory and Northern Texas. A line to Topeka, Kan., is now in service.

The officers of the company are: J. J. Heim, president; Henry Koehler, Jr., first vice-president; O. C. Snider, second vice-president, treasurer and general manager, and Hugh C. Ward, secretary. The directors of the company are: J. J. Heim, O. C. Snider, Hugh C. Ward, Walter S. Dickey and J. J. Swofford, of Kansas City; Max Koehler, Henry Koehler, Jr., Lee Benoist and A. W. Lambert, of St. Louis; Ed. L. Barber, of Wauseon, Ohio; James S. Brailey, Jr., of Toledo, Ohio, and Arnold Kahlman, of St. Paul. The officers of the long-distance company, known as the Western Independent Telephone Company, with an authorized capital of $1,500,000, are: Ed. L. Barber, president; J. J. Heim, vice-president, and O. C. Snider, secretary and treasurer.

Rocky Mountain Bell Telephone System.

The Rocky Mountain Bell Telephone Company, which has its headquarters at Salt Lake City, Utah, operates over the largest territory of any telephone company in the United States, and there are many interesting features connected with its rapid growth of the last few years. The toll line system covers the States of Utah, Idaho, Montana and Wyoming, the total area of which is 409,465 square miles. This area is larger by 90,000 miles than the Pacific Coast States, in which the Pacific States Telephone Company operates, and by way of comparison is 10,000 miles larger than the combined area of all the States lying south of Mason and Dixon's line, and between the Atlantic Ocean and the Mississippi River. This vast territory of the Rocky Mountain Bell Telephone Company is quite sparsely settled except in a few spots, where fertile valleys and mining camps have created cities and well-settled communities. In these four States the company has 6,000 miles of pole lines, with 16,000 miles of circuits, practically all of which are copper. The greatest stretch of connected lines is from the Wyoming-Colorado State boundary to the Washington-Idaho State boundary—a distance of 1,201 miles. The total number of subscribers of the company, including the city subscribers, was 19,000 in January and there were 96 exchanges in operation and 700 towns connected. During the last year 800 miles of new pole line were constructed, while the year's total growth of the company's system over the previous year was 39 per cent., a remarkable growth, but one which is entirely commensurate with the rapid development of the States of the Northwest.

The largest exchange is in Salt Lake City, where the company had 5,300 subscribers in January, an increase of 46 per cent. over the previous year. Butte has the next largest exchange with 1,800 subscribers, and Ogden comes next with 1,400 subscribers. Other good-sized exchanges are located at Provo and Logan, Utah; Pocatello and Boise, Idaho; Helena, Mont; Cheyenne and Laramie, Wyo.

At Salt Lake City during the last year the company has been engaged in putting its wires underground in the business district, and extending the conduit into the residence districts. At the present time there are over seven miles of conduit in the city. Electrolysis-proof paper conduit is used, it being laid in concrete in 8-ft. lengths. About 4,000 ft. of similar underground work has been done at Ogden. Other work of the year includes the erection of a new building in Cheyenne and the improvement of other buildings.

The toll-line system connects with the lines of the Colorado Telephone Company at Cheyenne and with the Pacific States Telephone system at Spokane, Wash.; Lewiston, Idaho, and Huntington, Ore., all three points being close to the western boundary of Idaho. A proposed connection with the Pacific States Telephone system through Nevada will follow the line of the Southern Pacific Railroad

around the north end of Great Salt Lake. Still another connection with the Pacific Coast system is proposed through the southwestern portion of Utah, following the general line of the San Pedro, Los Angeles & Salt Lake Railway, which is now nearing completion. A connection with the lines of the Colorado Telephone Company is proposed at Grand Junction in the western part of Colorado.

The company's toll service is very good, that between Salt Lake City and Denver being of special excellence, when the distance, 800 miles, is considered. On this line the company operates through eight exchanges. Knife switches are used as cut-outs, thus giving a practically clean line, the drops being bridged in through 5,000-ohm resistances. The company has six circuits running north of Salt Lake City and five south.

In Salt Lake City, Ogden, Butte and Boise common-battery exchange systems are installed and common battery is used for calling in 16 other stations. Party lines are limited to four parties on one circuit for city subscribers, which adds greatly to the general quality of the service. In subscribers and rural districts 10-party lines are allowed.

The company has had a very satisfactory growth in these party lines in rural communities. One striking example is the Snake River Valley in Idaho, where a district about 10 miles wide and extending for 100 miles along the Snake River has been the scene of a wonderful development in rural telephones. That section with good irrigation and a fertile soil has been rapidly settled and practically every farm the entire length of the valley is now connected with the outside world by means of 10-party telephone lines, No. 9 B. B. Galvanized-iron wire is used with 2,500-ohm bells and $2 a month is charged for the service, the farmers erecting and owning the poles and lines.

The Rocky Mountain Company as yet has not met severe competition and in several instances has added to its system by the purchase of isolated independent plants. Competing companies are now operating at Boise, Idaho; Billings, Mont., and Salt Lake City.

As in the case of the Colorado Telephone Company, whose system was described in the ELECTRICAL WORLD AND ENGINEER in August, 1903, the Rocky Mountain company has to operate and maintain its toll lines through some wild and rugged mountainous country. Some of the greatest trouble it has had, however, has been occasioned by fires and storms in the timber districts. On the line between Missoula, Mont., and Spokane, Wash., the company has had a gang of men at work ever since it was built four years ago, cutting the timber down on both sides of the line. As one expedient to avoid the breaking of the line in case of trees falling across it, the wires were hung underneath the cross arms, so that the line would be carried to the ground in case of storms and still remain in operating condition. Another point at which great trouble has been experienced is the Fourth of July Cañon in Idaho, where for 25 miles the line is frequently put out of service by falling timber, deep snow, heavy winds or floods. The Rocky Mountain Bell Telephone Company is under the energetic and progressive management of Mr. David S. Murray.

Electric Trolleys in Peru.

The first electric railway in Peru was formally opened to the public at Lima, February 17, with ample ceremony and great rejoicing by the populace. The road connects Miraflores, Baranco and Chorillos, summer resorts, with Lima, and is 23 miles long. It really was built in record time. The company applied to the government for a charter to build the road December 9, 1902; the concession was granted January 20, 1903; work began June 11, of that year; the road was completed January 18, 1904, and inaugurated February 17. President Manuel Candamo, of the Peruvian Republic, who is the formal sponsor of the road, replied to the address delivered by its president, Jose Payan, and Archbishop of Lima, Manuel Tovar, invoked divine aid and pronounced the benediction upon the new enterprise. Manuel T. Marca, chief engineer of the city railroads of Lima, is engineer for the new road. W. McLimont is electrical engineer, and Emilio Godoy, manager. The cars and electric plant are of American manufacture.

A few months more will witness the completion of another electric tramway line between Callao and Lima. The road is about 10 miles long, double track. The opening of this road will have a marked effect in drawing Lima and its port, Callao, even more closely together than they are at present.

The Design of Induction Motors with Examples from Recent European Practice.

By H. M. Hobart.

THROUGH the courtesy of the manufacturers, the writer has had recently placed at his disposal the particulars of a number of interesting English and Continental induction motor designs for large capacities. A tabulated analysis of these designs affords an opportunity of illustrating a useful practical method of carrying through the induction motor calculations. The designs are set forth in Table I in columns *A*, *B*, *C* and *D*. In column *A* is given a motor of Messrs. Brown, Boveri & Co. (Switzerland). The design in column *B* is by Mr. Danielson and is built by the Allmana Svenska Elektriska Aktiebolaget, of Westeras, Sweden. The design in column *C* is that of a motor by the Alioth Company, of Basel, Switzerland. The motor in column *D* was designed by Mr. Zani for Messrs. Dick, Kerr & Co., of Preston, England. In column *E* has been added the less recent but very interesting design by the Alioth Company, for a motor of 500 hp. The range of designs thus extends from 75 hp to 500 hp and the table is arranged in the order of increasing output, thus facilitating the study of the designs:

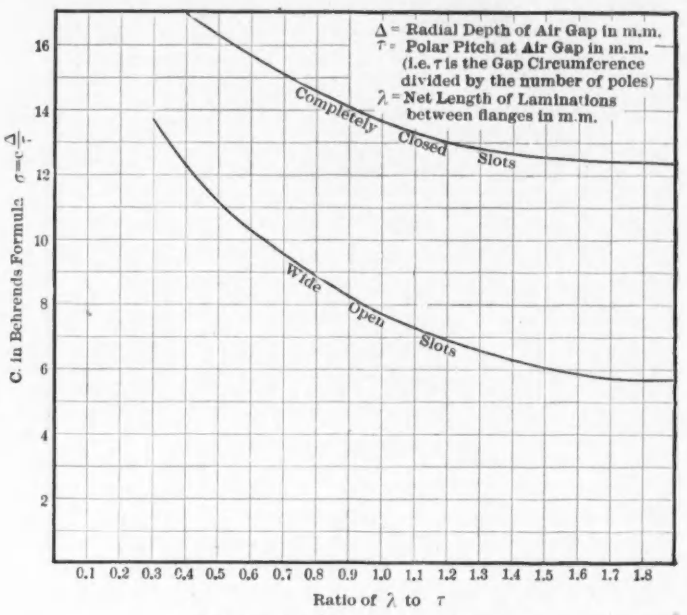

Δ = Radial Depth of Air Gap in m.m.
τ = Polar Pitch at Air Gap in m.m. (i.e. τ is the Gap Circumference divided by the number of poles)
λ = Net Length of Laminations between flanges in m.m.
Completely Closed Slots
Wide Open Slots
C. in Behrends Formula σ = C C¹ Δ/τ
16
14
12
10
8
6
4
2
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8
Ratio of λ to τ

FIG. 1.—DIAGRAM OF CURVES.

The calculations in Table I are thought to be so clear as to require no explanation further than as regards the dispersion coefficient σ.

This has been calculated by employing Behrend's formula in the form

$$\sigma = C\,C^1\frac{\triangle}{\tau},$$

in which

$\triangle$ = radial depth of air-gap,

and τ = polar pitch at air-gap.

C and C^1 are two constants obtained respectively from the curves of Figs. 1 and 2. C is dependent upon the ratio $\frac{\lambda}{\tau}$, in which λ = core length between flanges. In the curves for C suitable allowance is made for the inductance of the end connections. C^1 is dependent upon $\triangle \times H$, in which H equals the average of the number of slots per pole on stator and rotor. In the curve for C^1 suitable allowance is made for the so-called "zig-zag" dispersion over the heads of the teeth.

The curve of Fig. 2 shows the great importance of employing a high value for $\triangle \times H$, for below 0.75 the curve rises rapidly and generally renders futile any attempt to improve the power factor by means of decreasing the radial depth of the air-gap. This "zig-zag" dispersion is almost negligible with many slots and moderately

TABLE I.

Designation	A	B	C	D	E
Country in which Manufactured	Switz'land	Sweden	Switz'land	England	Switz'land
Manufacturer	Brown, Boveri & Co.	Allmanna Svenska El. Ak.	Alioth Co.	Messers. Dick, Kerr & Co.	Alioth Co.
Designer		E. Danielson	——	A. P. Zani	—
Rated hp	75	100	185	220	500
Number of poles	8	12	14	12	30
Periodicity in cycles per sec	50	50	50	50	25
Synchronous speed in r.p.m	750	500	430	500	100
Voltage between terminals	500	500	8,000	5,000	5,000
Connection of stator windings	△	Y	Y	Y	Y
Voltage per phase	500	288	4,620	2,880	2,880
STATOR-LAMINATIONS.					
External diam. of stator punchings (cm.)	70.0	103	162	145	332
Internal diam. of stator punchings (cm.)	50.2	88	130	109	300
Gross length between flanges (λg)(cm.)	28	36	40	30.5	75
Number of ventilating ducts	None	2	None	3	None
Width of each duct (cm.)	—	1.5	—	1.3	—
Net length of laminations between flanges (λn)(cm.)	25.2	29.7	36	23.9	67.5
Polar pitch at air gap (τ) (cm.)	19.7	23	29.2	28.5	31.4
Number of stator slots	72	180	168	108	450
Number of stator slots per pole	9	15	12	9	15
Number of stator slots per pole per phase	3	5	4	3	5
Depth of stator slot (mm.)	45	25	52	39	57
Width of stator slot (mm.)	16	10.5	13	21.6	13
Width of stator slot opening (mm.)	3.0	3.0	2.0	4.0	3.0
Stator tooth pitch, at air gap (mm.)	21.8	15.3	24.3	31.6	2.09
Stator tooth pitch, at ends of the slots (mm.)	23.6	16.2	26.3	34	21.7
Minimum width of stator tooth (mm.)	6.6	4.8	11.3	10.0	7.9
Maximum width of stator tooth (mm.)	7.6	5.7	13.3	12.4	8.7
Weight of stator punchings (kg.)	265	410	1,750	1,220	3,570
ROTOR-LAMINATIONS.					
Radial depth of air gap (△) (mm.)	1.0	1.5	1.25	1.6	1.75
External diam. of rotor punchings (cm.)	50.0	87.7	129.75	108.68	299.65
Internal diam. of rotor punchings (cm.)	35.0	75.7	101.0	86.5	284.0
Gross length between flanges (λg)(cm.)	28	36	40	30.5	75
Number of ventilating ducts	None	2	None	3	None
Width of each duct (mm.)	—	15	—	13	—
Net length of laminations between flanges (λn)(cm.)	25.2	29.7	36	23.9	67.5
Number of rotor slots	96	216	294	144	720
Number of rotor slots per pole	12	18	21	12	24
Number of rotor slots per pole per phase	4	6	7	4	8
Depth of rotor slot (mm.)	35	21.5	23	39.4	22
Width of rotor slot (mm.)	10	8	7.5	11.8	7
Width of rotor slot opening (mm.)	2	3	2	1.6	2
Rotor tooth pitch (at air gap)	21.8	12.8	13.9	23.7	13.1
Rotor tooth pitch (at bottom of the slots)	18.8	12.1	13.4	21.9	12.9
Minimum width of rotor tooth (mm.)	8.8	4.1	5.9	10.1	5.9
Maximum width of rotor tooth (mm.)	11.8	4.8	6.4	11.9	6.1
Weight of rotor punchings (kg.)	145	270	1,340	515	3,400
STATOR WINDING.					
Number of stator conductors per spot	42/4	3 (Each with 2 compounds)	27	33 Each consisting of 2 components	8
Number of stator slots	72	180	168	108	450
Number of stator conductors	756	540	4,536	3,564	3,600
Number of stator turns	378	270	2,268	1,782	1,800
Number of stator turns per phase	126	90	756	594	600
Number of stator turns per pole per phase	15.75	7.5	54	49.5	20
Dimensions of conductors, bare (mm.)	2.9	2×(2.5×6.5)	ø2.5	2+ø=2.34	ø 5.0
Dimensions of conductors, insulated (mm.)	3.5	2×(2.0×7.0)	ø3.0	—	ø 5.6
Cross-section of conductor (sq. cm.)	4 × .066 = .264	.324	.049	2×.0403=.086.	.197
Mean length of one turn	140	150	205	159	288

TABLE I. (*Continued.*)

	A	B	C	D	E
Total length of stator turns per phase (cm.)	17,700	13,500	15,500	94,000	173,000
Resistance per phase at 60° C	0.134	.084	6.3	2.2	1.75
Weight of stator copper (kg.)	126	117	203	3=72=216	910
ROTOR WINDINGS.					
Number of rotor conductors per slot	2	2	1	2	1
Number of rotor slots	96	216	294	144	720
Number of rotor conductors	192	432	294	288	720
Number of rotor turns	96	216	147	144	360
Number of phases in rotor winding	3	3	3	3	3
Number of rotor turns per phase	32	72	49	48	120
Number of rotor turns per pole per phase	4	6	3.5	4	4
Dimensions of conductor, bare (mm.)	6 × 12	4.5 × 8	16.5×5	16×9	16×5
Dimensions of conductor, insulated (mm.)	7.5 × 13.5	5 × 8.5	17×5.5	16.5×9.5	16.5×5.5
Cross-section of single conductor (sq. cm)	0.72	.36	.825	1.43	.8
Mean length of one turn	112	144	185	150	240
Length of effective rotor turns per phase (cm.)	3,580	10,400	9,060	7,200	28,800
Resistance per phase at 60° C	.010	.058	.0219	.01	.072
Weight of rotor copper (kg.)	69	100	200	273	615
POWER FACTOR AND CURRENT.					
Length of laminations / Pole pitch ($\frac{\lambda g}{\tau}$)	1.42	1.57	1.37	1.07	2.39
Type of slot (average of stator and rotor)	Closed	Closed	Nearly	Nearly	Nearly
C in Behrend's formula (from Fig. 1)	Nearly	⅔	Closed	Closed	Closed
$\frac{\triangle}{\tau} \times H =$	11.0	10.6	12	12.5	10.5
C′ in Behrend's formula (from Fig. 2)	1.05	2.5	2.06	1.68	3.4
Dispersion coefficient σ $\left[\sigma = CC' \frac{\triangle}{\tau}\right]$	1.21	.84	.93	1.0	.71
Maximum power factor $= \left(\frac{1}{1 + 2\sigma}\right)$	0.068	0.058	0.048	0.070	0.042
Watts output at full load	.88	.895	.912	.876	.922
Full load efficiency	55,200	73,600	136,000	164,000	368,000
Watts input at full load	93.5	90.0	93.0	93.5	91.0
Volt amperes input at full load	59,200	81,900	146,000	175,000	405,000
Volt amperes input per phase	67,000	91,500	160,000	202,000	435,000
Volts per phase	22,400	30,500	53,300	68,000	145,000
Full load amperes per stator winding	500	288	4,620	2,880	2,880
Type of connection	44.8	106	11.5	23.5	50.5
	△	Y	Y	Y	Y
Full load line amperes	77.5	106	11.5	23.5	50.5
NO LOAD, AND SHORT CIRCUIT CURRENT.					
Periodicity (in cycles per sec.) (N)	50	50	50	50	25
Number of stator turns per phase (T)	126	90	756	594	600
Approx. Int. voltage per phase (E)	490	280	4,550	2,800	2,800
Megalines flux per pole (M) [from $E=4.2=T\ N\ M\ 10^{-8}$]	1.85	1.48	2.86	2.24	4.50
Per cent. exposed iron at stator surface	85	80	92	87	86
Per cent. exposed iron at rotor surface	89	80	92	.88	90
Mean for stator and rotor (P)	87	80	92	87.5	88
Exposed cross-section of iron at air gap per pole ($=\lambda n T_P$)	430	544	965	595	1,860
Spreading coefficient	1.15	1.15	1.15	1.15	1.15
Corrected air gap cross-section per pole	495	625	1,110	685	2,140
Average gap density	3,720	2,370	2,580	3,280	2,100
Maximum gap density	6,320	4,030	4,380	5,600	3,570
Ampere turn for gap per pole	505	480	436	720	500
Total ampere turns per pole	565	540	490	810	560
Ampere turns per pole per phase	282	270	245	405	280
Maximum current at no load	17.9	36	4.55	8.2	14
R.m.s. Current at no load	12.6	25.5	3.2	5.8	9.8
R.m.s. at no load in per cent. of full current	28.1	23.5%	27.3%	24.6	19%
$\sigma =$	0.068	.058	.048	.076	.042
Current Corres. to the diam. of the circle $\frac{\text{No-load Cur.}}{\sigma}$	185	440	66.7	76.5	233
Ideal short-circuit current	198	465	70	82.3	243

TABLE I. (*Concluded.*)

DESIGNATION	A	B	C	D	E
Secondary current at full load (from circle diagram for ratio 1:1 of transformation)	42.5	97.5	10.5	21.5	47.5
Number of stator conductors	756	540	4,536	3,564	3,600
Number of rotor conductors	192	432	294	288	720
Ratio of transformation	3.95	1.25	15.4	12.3	5
Actual secondary current	168	121	162	265	237
LOSSES.					
I. C^2R LOSS OF STATOR.					
Current in stator winding	44.8	106	11.5	23.5	50.5
Resistance of stator winding per phase	.134	0.084	6.3	2.2	1.75
C^2R loss of stator per phase	268	950	835	1,210	4,450
Total C^2R loss of stator	800	2,850	2,505	3,630	13,350
II. C^2R LOSS OF ROTOR.					
Current in rotor winding	168	121	162	265	237
Resistance of rotor winding per phase	0.1	.058	.0219	.01	.072
C^2R loss of rotor per phase	282	850	575	700	4,050
Total C^2R loss of rotor	850	2,850	1,625	2,100	12,150
Slip of rotor	1.5%	3.4%	1.2%	1.3%	3.1%
III. IRON LOSS OF STATOR.					
Minimum cross-section of stator teeth per pole	150	214	490	215	800
Average density at these points	12,300	6,900	5,840	10,400	5,620
Maximum density at these points	20,900	11,700	9,900	17,700	9,600
Depth of stator iron above teeth (cm.)	5.35	5.0	10.8	1.4	5.3
Cross-section of stator turn	272	297	276	670	715
Density of stator turn	6,800	5,000	3,700	3,350	6,300
Periodicity (in cycles per sec.) (C)	50	50	50	50	25
Density of stator iron in kilolines (*D*)	6.80	5	3.7	3.35	6.3
$\frac{DC}{100}$	3.4	2.5	1.85	1.67	1.58
Watts stator core loss per kg	5.4	3.9	2.8	2.5	2.4
Weight of stator punchings (kg.)	265	410	1,750	1,220	3,570
Core loss in stator iron	1.43a	1,600	4,900	3,050	8,600
IV. IRON LOSS OF ROTOR.					
Cross-section of rotor teeth at narrowest point	266	219	448	288	960
Average density of rotor teeth at narrowest point	7,000	6,800	6,400	7,800	4,700
Maximum density of rotor teeth	11,800	11,550	10,900	13,200	8,000
Depth of rotor iron below slot	4.0	3.85	12.1	7	5.6
Cross-section of rotor iron	202	228	870	335	755
Density in rotor iron	9,200	6,500	3,300	6,700	5,950
Slip	1.5%	3.4%	1.2%	1.3%	3.1%
Weight of rotor punchings	145	270	1,340	515	3,400
Iron loss in rotor	250	50	35	40	250
V. FRICTION LOSS IN BEARINGS AND THROUGH WINDINGS.	650	1,400	1,500	2,000	2,300
TOTAL OF LOSSES.					
Variable losses (I and II)	1,650	5,400	4,130	5,730	25,500
Constant losses (III, IV and V)	2,330	3,050	6,535	5,090	11,150
Total losses	3,980	8,450	10,665	10,820	36,650
Output in watts	55,200	73,600	136,000	164,000	368,000
Input in watts	59,180	82,050	146,665	174,820	404,650
Full load efficiency	93.5	89.9	92.8	93.8%	91
WEIGHTS.					
Weight of stator copper (kg.)	126	117	203	216	910
Weight of rotor copper (kg.)	69	100	200	273	615
Total weight of copper	195	217	403	489	1,525
Weight of stator laminations	265	410	1,750	1,220	3,570
Weight of rotor laminations	145	270	1,340	515	3,400
Total weight of laminations	410	680	3,090	1,735	6,970
Total weight of active material	605	897	3,493	2,224	8,495
Weight of active material per hp output (kg.)	8.1	9	19	10	17

deep air-gaps, but with few slots and short air-gaps it may rise to a very high figure, and thus it appears that very short air-gaps, besides being mechanically undesirable, lead to far less gain than is generally believed. The range of satisfactory practical designs generally lies between values of 0.8 and 4.0 for $\triangle \times H$, though

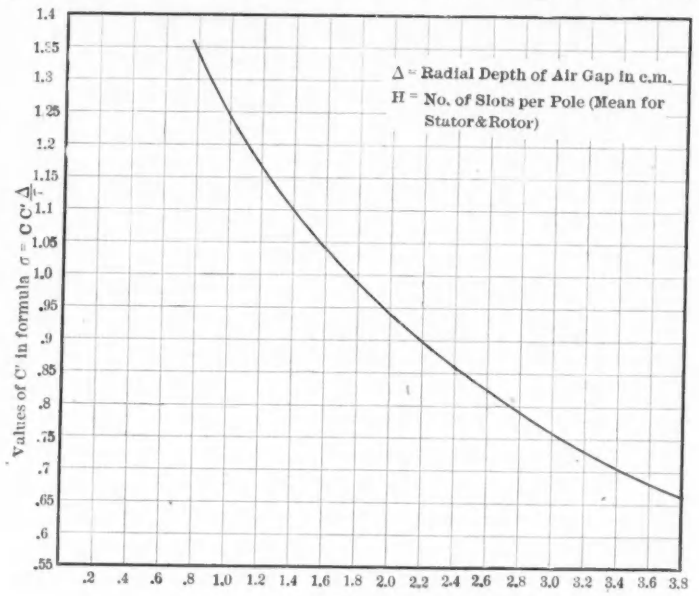


FIG. 2.—CURVE.

for very small motors, values less than 0.8 must occasionally be used, and a precise predetermination of σ is then rendered difficult owing to the inaccuracy in estimating the "zig-zag" component of the total dispersion. With the tendency to employ lower periodicities, the values for both $\triangle$ and H will increase in the near future. This analysis of the phenomena should afford an additional argument against relying on high values of τ and small values of $\triangle$ as means for obtaining high power factors. The curves of Fig. 1 show that high values of τ may lead to such increased inductance of the end connections as to limit improvement in this direction, and the curve of Fig. 2 shows that when $\triangle$ is decreased beyond certain limits, the "zig-zag" dispersion increases so rapidly as to limit any considerable power factor improvement by this means.

The data set forth in Table II (page 808) on 57 induction motors, of eight different manufacturers in four different countries, contain ample proof that the estimation of σ by means of the curves in Figs. 1 and 2 gives results in far closer agreement with the observed results than has heretofore been believed to be possible. In compiling Table II I have employed all the cases I had at hand, where the observed results could be considered as having been carried out with reasonable care and intelligence, omitting only those cases for which $\triangle \times H$ was less than 0.75, since these may be considered to be exceptional, and to be in general, undesirable when they can be avoided. A large number of these examples of observed results were obtained from the data in Dr. Behn-Eschenburg's recent very valuable paper on the dispersion coefficient.* In this paper Dr. Behn-Eschenburg set forth a collection of experimental data of very great value. He also deduced a very interesting formula for estimating σ, which had the great advantage of being in the form of three separate terms relating respectively to the slot dispersion, the flank dispersion and the "zig-zag" dispersion. The results by Dr. Behn-Eschenburg's method do not, however, agree with observations so well as do those obtained by the method employed in this article.

These curves in Figs. 1 and 2 probably permit of a more accurate determination of σ than is in practice generally obtained in factory tests and with the customary rough methods employed in mechanical measurements of $\triangle$, the radial depth of the air-gap.

For squirrel-cage motors, a third constant, C^{11}, may be added and the formula may be written:

$$\sigma = C\,C^{1}\,C^{11}\,\frac{\triangle}{\tau}.$$

C^{11} will generally be about 0.75, and where no more precise basis for its determination is available, it should be so taken.

* Institution of Electrical Engrs. of Great Britain, Dec. 10, 1903.

TABLE II.

Reference Number	Manufacturer.	Number of Poles.	Squirrel Cage (S) or Wound Rotor (W).	C″ for Sq. Cage Rotor.	H_1 (No. of Stator Slots).	H_2 (No. of Rotor Slots).	H average of Stator & Rotor Slots per Pole.	X Av. Slot Opening for Stator and Rotor.	λg Gross Length of Arm. Laminations between Flanges.	τ Polar Pitch or Air Gap.	Δ	$\frac{\lambda g}{\tau}$	$\Delta \times H$	In Behrend's Formula $\sigma = \frac{C'}{C} \frac{\Delta}{\tau}$		Estimated Value of σ	Observed Value of σ	Disagreement between Est. & Observed Values in % of Observed values σ	Remarks.
														C'	C				
1	Oerlikon	4	W		72	96	21.0	0.10	10	22.8	0.065	0.44	1.37	16.0	1.11	0.051	0.06	15	.....
2	"	6	W		72	96	14.0	0.10	10	15.2	0.065	0.66	0.91	14.5	1.26	0.078	0.09	13	.....
3	"	4	W		72	96	21.0	0.10	14.5	22.8	0.065	0.64	1.37	14.7	1.11	0.047	0.045	4	.....
4	"	6	W		72	96	14.0	0.10	14.5	15.2	0.065	0.94	0.91	13.2	1.26	0.071	0.075	5	.....
5	"	6	W		72	120	16.0	0.10	19.0	25.7	0.080	0.74	1.28	14.1	1.13	0.050	0.05	0	.....
6	"	8	W		72	120	12.0	0.10	19.0	19.3	0.080	0.99	0.96	13.1	1.25	0.068	0.063	8	.....
7	"	6	W		72	120	16.0	0.10	28.0	25.7	0.080	1.09	1.28	12.6	1.13	0.044	0.042	5	.....
8	"	8	W		72	120	12.0	0.10	28.0	19.3	0.080	1.45	0.96	11.8	1.25	0.061	0.056	9	.....
9	"	12	W		144	180	13.5	0.10	17.0	23.6	0.100	0.72	1.35	14.1	1.11	0.066	0.067	2	.....
10	"	12	W		144	120	13.5	0.10	40.0	23.6	0.100	1.70	1.35	11.7	1.11	0.055	0.046	20	.....
11	"	8	W		96	144	15.0	0.10	24.0	22.8	0.090	1.05	1.35	12.6	1.11	0.055	0.054	2	.....
12	"	12	W		144	180	13.5	0.0	32.5	23.6	0.110	1.38	1.49	12.5	1.06	0.062	0.070	11	.....
13	"	12	W		144	180	13.5	0.35	32.5	23.6	0.110	1.38	1.49	10.3	1.06	0.051	0.06	15	.....
14	"	8	W		96	144	15.0	0	24.0	22.8	0.090	1.05	1.35	13.3	1.11	0.058	0.054	7	.....
15	"	8	W		96	144	15.0	0.70	24.0	22.8	0.110	1.05	1.65	10.6	1.01	0.052	0.062	16	.....
16	"	14	W		168	210	13.5	0.15	28.0	33.8	0.100	0.85	1.35	13.1	1.11	0.043	0.046	7	.....
17	"	14	W		168	210	13.5	0.15	28.0	33.8	0.140	0.85	1.88	13.1	0.96	0.052	0.055	5	.....
18	"	12	W		108	144	10.5	0	40.0	24.6	0.100	1.63	1.05	12.4	1.20	0.061	0.054	13	.....
19	"	8	W		120	160	17.5	0.10	30.0	22.8	0.070	1.31	1.22	12.0	1.14	0.042	0.042	0	.....
20	"	4	W		120	160	35.0	0.10	30.0	45.6	0.070	0.66	2.44	14.5	0.85	0.0789	0.022	14	.....
21	"	12	W		144	180	13.5	0.15	23.0	23.6	0.100	.098	1.35	12.9	1.09	0.060	0.067	10	.....
22	"	6	W		144	180	27.0	0.15	23.0	47.2	0.100	0.49	2.7	15.3	0.86	0.0260	0.033	21	.....
23	"	8	W		72	120	12.7	0.10	19.0	19.3	0.070	0.99	0.84	12.9	1.30	0.061	0.064	5	.....
24	"	4	W		72	120	24.0	0.10	19.0	38.5	0.070	0.52	1.68	15.0	1.01	0.0276	0.034	19	.....
25	"	12	W		144	180	13.5	0.15	32.0	23.6	0.100	1.36	1.35	11.8	1.09	0.055	0.06	8	.....
26	"	8	W		144	180	20.3	0.15	32.0	35.4	0.100	0.91	2.03	12.9	0.92	0.0335	0.043	22	.....
27	"	6	W		54	72	10.5	0.20	24.0	19.9	0.080	1.21	0.84	11.8	1.29	0.061	0.054	13	.....
28	"	6	W		108	144	21.0	0.10	24.0	19.9	0.080	1.21	1.68	11.4	1.02	0.047	0.039	21	.....
29	"	16	W		144	192	10.5	0	22.0	29.6	0.150	0.75	1.57	14.6	1.05	0.078	0.075	4	.....
30	"	16	W		192	216	12.8	0.25	22.0	29.6	0.150	0.75	1.92	13.2	0.94	0.063	0.065	3	.....
31	"	8	S	0.75	96	144	15.0	0.10	24.0	22.8	0.090	1.05	1.35	12.6	1.09	0.041	0.037	11	.....
32	A.E.G.	6	W		90	140	19.2	0.25	16.6	23.0	0.100	0.72	1.92	12.9	0.94	0.053	0.042	26	Kapp-Elek-Kon. p. 174
33	"	10	W		150	262	20.0	0.35	25.0	26.8	0.150	0.94	3.00	12.0	0.75	0.051	0.065	22	" " p. 161
34	S. & H.	8	W		120	72	12.0	0.20	25.0	20.6	0.125	1.22	1.50	12.0	1.06	0.077	0.089	14	" " p. 261
35	Alioth	14	W		168	294	16.5	0.20	40.0	29.2	0.125	1.37	2.06	12.0	0.92	0.47	0.050	6	.....
36	"	30	W		450	720	19.5	0.25	76.0	31.4	0.175	2.39	3.40	10.6	0.70	0.41	0.036	14	.....
37		12	W		180	216	16.5	0.30	36.0	23.0	0.150	1.56	2.46	10.7	0.85	0.59	0.052	14	.....
38		4	S	0.75	72	105	22.1	0.25	20	29.9	0.19	0.67	4.2	14.6	0.65	0.045	0.034	32	.....
39		6	W		72	105	14.8	0.25	20	199	0.10	1.01	1.48	12.5	1.07	0.067	0.066	2	.....
40		8	W		72	105	11.1	0.25	20	15.0	0.11	1.34	1.22	15.5	1.14	0.096	0.088	19	.....
41		10	W		90	105	9.8	0.25	20	11.9	0.11	1.68	1.07	11.2	1.20	0.124	0.099	25	.....
42	Allmanna Svenska Elektriska Aktiebolaget.	4	W		60	84	18.0	0.25	21.5	39.4	0.15	0.55	2.7	14.8	0.80	0.045	0.051	12	.....
43		6	W		108	126	19.5	0.25	21.5	26.3	0.16	0.82	3.13	13.1	0.74	0.059	0.058	2	.....
44		8	W		120	141	16.3	0.25	21.5	19.7	0.13	1.09	2.12	12.2	0.91	0.073	0.065	12	.....
45		10	W		120	141	13.1	0.25	21.5	15.8	0.14	1.37	1.83	11.6	0.97	0.100	0.078	28	.....
46		16	W		192	288	15.0	0.3	42	20.8	0.145	2.03	2.18	11.0	0.91	0.070	0.062	13	.....
47		28	W		420	378	14.3	0.3	22.5	19.2	0.16	1.17	2.28	11.5	0.88	0.084	0.073	15	.....
48		72	W		864	648	10.5	0.4	40.4	13.7	0.23	2.94	2.42	10.7	0.85	0.153	0.129	19	.....
49	Mavor & Coulson	4	S	0.75	48	67	14.4	0.30	15.2	24	0.08	0.63	1.12	14	1.2	0.042	0.056	25	.....
50	"	4	S		72	119	24	0.35	30.4	36	0.25	0.84	6	12	.63	0.04	0.048	17	.....
51	Firm A	8	W		72	96	10.5	0.40	11.4	14.0	0.082	0.82	0.860	12.0	1.3	0.09	0.143	37	.....
52	"	8	W		72	96	10.5	0.40	15.8	14.0	0.082	1.13	0.860	10.6	1.3	0.080	0.112	20	.....
53	"	8	W		72	120	12.0	0.40	14.6	20.8	0.114	0.70	1.37	13.3	1.1	0.08	0.091	12	.....
54	"	4	S	0.75	72	67	17.4	0.40	19.7	41.6	0.114	0.475	1.98	14.9	0.94	0.029	0.0297	2	.....
55	"	6	W		108	126	19.5	0.40	22.3	39.6	0.158	0.565	3.12	14.0	.74	0.041	0.0365	12	.....
56	Brown, Boveri & Co.	6	W		54	72	10.5	0.3	20.0	16.8	0.075	1.19	0.79	11.6	1.34	0.069	0.055	26	.....
57	"	8	W		72	96	10.5	0.3	28.0	19.7	0.100	1.42	1.05	11.0	1.21	0.068	0.060	13	.....

The Elementary Principles of Transformer Design.—II.
(*Concluded.*)

BY PROF. THOMAS GRAY.

In the discussion just given the links have, as already stated, been considered as rectangular with square corners, and it will be noticed that in the applications given below no account is taken of the variable section at these corners or of the variable flux across the section due to variation of length between the inside and outside of the link. The coefficient of hysteresis is assumed to apply to the sections considered. There is, however, an element involved here which is of considerable importance and which is generally, if not always, neglected. Suppose, for example, that the coefficient and exponent in the equation, $H = h B^a$, for heat dissipation in the iron, has been determined from straight samples or from rings in which the internal and external radii do not differ greatly from each other. The question naturally arises, Can the value so obtained be applied to the ordinary forms? As an illustration, assume a circular ring the material section of which is rectangular, internal radius r_1 and external radius r_2. For moderate variations near ordinary values of induction density, B may be taken as inversely as the radius.

Let, therefore, $B = \frac{a}{x}$ where a is a constant and x is the radius of any elementary ring. Let the breadth of the ring section be unity and assume the ordinary form of expression for the hysteresis as given above.

Then

$$d H = h B^a . 2\pi x \, d x = 2\pi h a^a x^{1-a} d x;$$

$$\therefore \quad H = 2\pi h a^a \frac{r_2^{2-a} - r_1^{2-a}}{2 - a}.$$

When $a = 1$,

$$H = 2\pi h a (r_2 - r_1),$$

which is the same as would be given by a uniform induction equal to the mean induction multiplied by the volume. In the actual case, however, a is greater than unity, approximates in fact, as was shown by Steinmetz, to 1.6 for ordinary working ranges of induction. In the general case the value of H calculated from the mean value of B would be:

$$H^1 = \pi h (r_2^2 - r_1^2) \left(\frac{2a}{r_1 + r_2} \right)^{a-1}$$

$$\therefore \quad \frac{H}{H^1} = \frac{2^{a-1} (r_2^{2-a} - r_1^{2-a}) (r_2 + r_1)^{a-1}}{(2 - a) (r_2 - r_1)}$$

When $a = 1.6$ this becomes

$$\frac{H}{H^1} = \frac{10 (r_2^{1.1} - r_1^{1.1}) (r_2 + r_1)^{0.6}}{2^{2.6} (r_2 - r_1)}$$

Suppose, as a practical case, that $r_1 = 5$ and $r_2 = 15$.

Then $H = 1.035 H^1$, which shows an increase due to a difference of radius of 3.5 per cent. If $r_1 = 1$ and $r_2 = 5$, the difference is 9.2 per cent., and when $r_1 = 0$ and $r_2 = 5$, $H = 1.65 H_1$. This last is, of course, an extreme case, but it is evident that the data to be used in the design of transformers should be determined from samples of similar shape to that proposed for use.

APPLICATION TO TRANSFORMER DESIGN.

Let the induction per sq. cm. of the core section be represented by $B \sin \omega t$, and, therefore, the total induction, $A B \sin \omega t$; then, since the magnetizing current is very small, the amplitude of the e.m.f. applied will, when the transformer is not loaded, be practically equal to that induced by self-induction. Thus, $E = \frac{n A B \omega}{10^8}$,

where n is the number of windings on the primary coil. If P be the required full-load activity, C the square root of the mean square of the full-load current in the primary, and the power factor for full load be taken as unity, $P = E C/\sqrt{2}$. Taking f as the average current per sq. cm. of coil section, the heat generated in the coils will be approximately $\frac{4}{10^6} f^2 v$ on the assumption that 50 per cent. of the combined coil section is copper and that the working temperature is 80° C. The coil sections should be so proportioned that the heat dissipations on the load which gives maximum efficiency, assumed in the example given as the full load, are equal. On full load as thus defined the heat generated in the iron due to combined hysteresis and eddy current should be equal to the total heat generated in the coils. This latter can in general be assumed to be entirely due to the ohmic resistance of the coils and the load currents, because in a transformer of good design there is practically no magnetic field in the coil space. In order to obtain definite numerical results for comparison the total iron heat has been assumed to follow the law given by Steinmetz, namely, $H = h B^a$, where $a = 1.6$. The value assumed for h, namely, $18/10^{11}$ in watts per cu. cm. per cycle per second, is founded on the writer's own measurements on transformers and agrees fairly well with similar measurements by Kapp and others. Better iron can no doubt be obtained and less insulation may in many cases be found sufficient, both of which would tend towards less weight and higher efficiency.

The value of f is determined from the number of wires per sq. cm., and the current in each and this will in general be different for the primary and secondary coil. No error is introduced by assuming half the coil space to each and a simple change of insulation, the same wires being used.

Hence, $f = 2 n_1 C/A = 2\sqrt{2 n_1} P/E A$. Equating the dissipation of energy in the coils to that in the iron,

$$\frac{4}{10^6} . f^2 v = \frac{32}{10^6} . \frac{n_1^2 P^2}{E^2 A^2} v = \frac{\omega}{2\pi} . h B^a v_1.$$

Another equation is obtained from the condition that a certain area of radiating surface must be allowed for each watt of heat dissipated. Let the total exposed surface be S and let s be the surface allowed per watt. The value of s depends on the method of cooling and the allowable rise of temperature above the surrounding air. Since the total heat is twice that generated in the iron,

$$2 \frac{\omega}{2\pi} . h B^a v_1 s = S.$$

Now, the values of $\frac{S a}{v_1}$ are shown by means of curves in Figs. 2 and 4 for different ratios of sections or volumes. Let the proper value for any case under consideration be g. Then

$$\frac{\omega}{\pi} . h B^a s a = \frac{S a}{v_1} = g.$$

It thus appears that for the determination of the proper induction, B_1, the proper number of windings, n, in the primary coil and the proper size indicated by a, A or v, etc., the following three equations besides those obtained for the ratios of the linear dimensions, etc., are available:

$$h B^a = \frac{\pi}{\omega} . \frac{g}{s a} \qquad (21)$$

$$h B^a = \frac{32}{10^6} . \frac{n_1^2 P^2}{E^2 A^2} . \frac{v}{v_1} . \frac{2\pi}{\omega} \qquad (22)$$

$$A_1 \text{ or } x A, \text{ or } x x_1 a^2 = \frac{10^8 E}{n_1 B \omega}. \qquad (23)$$

In equation (23) x_1 is put for b/a, which for any given ratio of sections or volumes can be found from the curves given.

Raising (21) to the fourth power and dividing by (22),

$$(h B^a)^3 = \frac{10^6}{64} . \left(\frac{\pi}{\omega} \right)^3 . \left(\frac{g}{s} \right)^4 . \frac{v_1}{v} . \frac{E^2 x_1^2}{n^2 P^2} \qquad (24)$$

From (21) and (23),

$$\frac{(h B^a)^4}{B^2} = \left(\frac{\pi}{\omega}\right)^4 \left(\frac{g}{s}\right)^4 \frac{n_1^2 \omega^2}{10^{16} E^2} \cdot x^2 x_1^2 \qquad (25)$$

(24) × (25) gives

$$\frac{(h B^a)^7}{B^2} = \frac{1}{64 \times 10^{10}} \cdot \left(\frac{\pi}{\omega}\right)^7 \left(\frac{g}{s}\right)^8 \cdot \frac{v_1}{v} \cdot \frac{\omega^2 x_1^4 x^2}{P^2} \qquad (26)$$

Hence, if $a = 1.6$ and $h = \frac{18}{10^{11}}$,

$$B^{9.2} = \frac{10^{67}}{64 \times 18} \cdot \left(\frac{\pi}{\omega}\right)^7 \cdot \left(\frac{g}{s}\right)^8 \cdot \frac{v_1}{v} \cdot \frac{\omega^2 x_1^4 x^2}{P^2}$$

$$= \frac{10^{67} \times \pi^2}{64 \times 32 \times 18^7} \left(\frac{2\pi}{\omega}\right)^5 \left(\frac{g}{s}\right)^8 \cdot \frac{v_1}{v} \cdot \frac{x_1^4 x^2}{P^2}$$

$$= 7.866 \times 10^{55} \times \left(\frac{2\pi}{\omega}\right)^5 \left(\frac{g}{s}\right)^8 \cdot \frac{v}{v_1} \cdot \frac{x_1^4 x^2}{P^2} \qquad (27)$$

which serves to determine B. Then, from (21),

$$a = \frac{2\pi}{\omega} \cdot \frac{g}{s} \cdot \frac{10^{11}}{36 B^{1.6}} \qquad (28)$$

and from (23),

$$n_1 = \frac{10^8 E}{x x_1 B \omega a_1} \qquad (29)$$

$$H = 2 \times 18 B^{1.6} v_1 \omega / 2\pi \times 10^{11}.$$

It would be better to determine n first, because in practice the number of terms should be a multiple of the transformation ratio and the change of n to fulfill this condition implies a corresponding change in a and B. The equation for the direct determination of n is not, however, convenient for calculation because of the fractional exponents involved. The number given in the following examples are those given by the above equations without any adjustment. The value of s assumed is 30, which is about the area required for the transformer in ordinary use without oil or artificial cooling. When the case is filled with oil s may be reduced to 20, even on continuous use, and hence a considerable saving in weight and an increase in efficiency is obtained.

Particular Examples.—Example (1): A two-link transformer is to have a capacity $P = 1{,}000$ watts, where $E = 3{,}000$ volts, $\frac{\omega}{2\pi} = 100$, $x = 1$, and $s = 30$.

Here $v = v_1$, $x_1 = 3$ and $g = 3.166$, and from equations (27) (29) the following values are found:

$B = 4{,}950$,	$A = A_1 = 38.75$,
$n = 2{,}490$,	$v = v_1 = 1{,}672$,
$a = 3.59$,	$v + v_1 = 5{,}344$.
$b = 10.78$,	

Total heat dissipated per second $= H = 2 \times 18 \times 49{,}501.6 \times 1{,}672 \times 100 = 49.08$ watts.

Efficiency = 95.1 per cent.

Example (2): With the same data as for (1) except that $P = 10$ kw, the following results are obtained:

$B = 3{,}000$,	$A = A_1 = 192.3$,
$n = 828$,	$v = v_1 = 18{,}470$,
$a = 8.01$,	$v + v_1 = 36{,}940$,
$b = 24.02$,	$H = 243.5$,
	Efficiency = 97.6 per cent.

Example (3): Same data as for (1) and (2) except that $P = 100$ kw.

$B = 1{,}819$,	$A = A_1 = 954$,
$n = 275$,	$v = v_1 = 204{,}100$,
$a = 17.83$,	$v + v_1 = 408{,}200$,
$b = 53.489$,	$H = 1{,}208$,
	Efficiency = 98.8 per cent.

Example (4): A three-link core transformer is to have a capacity of one kilowatt when $E = 3{,}000$ and $A = A_1$.

The same formulæ apply in this case, but when $x = 1$, $x_1 = 2$, $b_1 a_1 = 3$, $v_1 v = 1.086$, and $g = 3.462$, the results are:

$B = 4.530$,	$v = 1{,}590$,
$n = 2{,}565$,	$v_1 = 1{,}730$,
$a = 4.539$,	$v + v_1 = 3{,}320$,
$b = 9.078$,	$H = 44.04$,
$A = A_1 = 41.17$,	Efficiency = 95.6 per cent.
$a_1 = 3.704$,	
$b_1 = 11.112$,	

Example (5): Same as (4), except that $P = 10$ kw.

$B = 2{,}747$,	$A = A_1 = 204.2$,
$n = 853$,	$v = 17{,}600$,
$a = 10.1$,	$v = 19{,}110$,
$b = 20.2$,	$v + v_1 = 36{,}710$,
$a_1 = 8.25$,	$H = 218.3$,
$b_1 = 24.75$,	Efficiency = 97.8 per cent.

Example (6): Same as (4), with the exception that the capacity is 100 kw.

$B = 1{,}664$,	$A = A_1 = 1{,}015$,
$n = 283$,	$v = 195{,}100$,
$a = 22.52$,	$v_1 = 212{,}100$,
$b = 45.04$,	$v + v_1 = 407{,}200$,
$a_1 = 18.39$,	$H = 1{,}087$,
$b_1 = 55.17$,	Efficiency = 99.1 per cent.

Example (7): Take the same case as (5), with the modification that the iron section is half the coil section, or $x = \frac{1}{2}$. In this case $v_1/v = .796$, $x_1 = 3$, $b_1/a_1 = 2$, and $g = 4.755$.

Example (7):

$B = 3.588$,	$A = 245$,
$n = 1{,}086$,	$A_1 = 122.5$,
$a = 9.04$,	$v = 15{,}940$.
$b = 27.12$,	$v_1 = 12{,}700$,
$a_1 = 7.83$,	$v + v_1 = 28{,}640$,
$b_1 = 15.65$,	$H = 222.6$,
	Efficiency = 97.8 per cent.

Comparing these results with those obtained in example (5), it appears that there is an advantage in the reduction of weight and in increased induction density, which for most kinds of good iron would mean greater permeability. The dissipation of energy is, of course, slightly greater, but only a little over 4 watts. For transformers of this type considerable economy of first cost will be got by making the iron section considerably smaller than the coil section.

Shell Transformers.—In the case of the shell type the double link is iron and the equations (27)—(29) have to be modified, as follows:

$$B^{9.2} = 7.866 \times 10^{55} \left(\frac{2\pi}{\omega}\right)^5 \left(\frac{g}{s}\right)^8 \left(\frac{v}{v_1}\right)^7 \frac{x_2^4}{x^2 P^2} \qquad (30)$$

$$a_1 = \frac{2\pi}{\omega} \cdot \frac{g}{s} \cdot \frac{v}{v_1} \cdot \frac{10^{11}}{36 B^{1.6}} \qquad (31)$$

$$n_1 = \frac{10^8 E}{x_2 B \omega a_1^2} \qquad (32)$$

In these equations, $x_2 = b_1/a_1$ and g is put $= \frac{S a_1}{v_1}$, instead of $\frac{S a}{v_1}$, so that the values can be more conveniently taken from the curve, Fig. 4.

Example (8): When the shell type is taken with the same data as in example (4) the only changes to be noted are that $x_2 = b_1/a_1$

$= 2$, being now the ratio of the dimensions of the total section of the double link, and that $\left(\frac{v}{v_1}\right)^7$ appears in the equation (30), instead of $\frac{v_1}{v}$ in equation (27). The results are as follows:

Example (8): Capacity, one kilowatt. $E = 3{,}000$.

$B = 4{,}778$, $A = A_1 = 40.82$,
$n = 2{,}445$, $v = 1{,}710$,
$a = 3.69$, $v_1 = 1{,}570$,
$b = 11.07$, $v + v_1 = 3{,}280$,
$a_1 = 4.52$, $H = 43.6$,
$b_1 = 9.03$, Efficiency $= 95.6$ per cent.

Example (9): Same as (8), with the exception that the capacity is 10 kw.

$B = 2{,}896$, $A = A_1 = 202.7$,
$n = 813$, $v = 18{,}890$,
$a = 8.22$, $v_1 = 17{,}400$,
$b = 24.65$, $v + v_1 = 36{,}290$,
$a_1 = 10.07$, $H = 216.2$,
$b_1 = 20.13$, Efficiency $= 97.84$ per cent.

Example (10): Keeping other things the same as in example (9), let the iron section be made twice the copper section. The results then become:

$B = 3{,}091$, $A = 124.9$,
$n = 618$, $A_1 = 249.7$,
$a = 7.90$, $v = 13{,}060$,
$b = 15.80$, $v_1 = 16{,}400$,
$a_1 = 9.12$, $v + v_1 = 28{,}140$,
$b_1 = 27.37$, $H = 226.6$,
Efficiency $= 97.7$ per cent.

Example (11): The same as (10), with exception of the ratio of iron to copper section. In this $A_1 = 5A$. The ratio $b_1/a_1 = 6$ and $b/a = 1.4$ in this case.

$B = 3{,}770$, $A = 59.93$,
$n = 420$, $A_1 = 299.6$,
$a = 6.54$, $v = 7{,}362$,
$b = 9.16$, $v_1 = 13{,}640$,
$a_1 = 7.06$, $v + v_1 = 21{,}000$,
$b_1 = 42.39$, $H = 260.2$,
Efficiency $= 97.4$.

When a transformer is on the circuit continuously, but only loaded for a few hours each day a greater all-day average efficiency may be obtained by choosing a transformer so designed that the iron heat dissipation is considerably less than that of the coil when loaded. The efficiency is, of course, smaller on full load. For such a case equations (29) and (30) should be modified to read:

$$B^{9.2} = 7.866 \times 10^{55} \left(\frac{2\pi}{\omega}\right)^5 \left(\frac{g}{s}\right)^8 \left(\frac{v}{v_1}\right)^7 \frac{x_2^4}{x^2 P^2} \cdot \frac{m-1}{m^8} \qquad (30)_2$$

$$a_1 = \frac{1}{m} \cdot \frac{2\pi}{\omega} \cdot \frac{g}{s} \cdot \frac{v}{v_1} \cdot \frac{10^{11}}{86\, B^{1.6}} \qquad (31)_2$$

Similar changes have, of course, to be made in equations (27) and (29) for the core types. In forming the modified equations the total heat dissipation is supposed to be m times the hysteresis dissipation.

Example (12): Let $m = 3$ and the other data be the same as in example (9).

$B = 2{,}195$, $A_1 = 218.6$,
$n = 921$, $v = 21{,}180$,
$a = 8.53$, $v_1 = 19{,}510$,
$b = 25.60$, $v + v_1 = 40{,}690$,
$a_1 = 10.45$, $Hi = 77.9$,
$b_1 = 20.90$, $Hc = 155.8$,
$A = 218.6$, $Hi + Hc = 233.7$,
Efficiency $= 97.66$.

The efficiency is thus 97.66 instead of 97.84, and the weight is considerably increased, but when the load is only on for six hours out of the twenty-four there is a saving of about 600 watts-hours per day.

The numbers given in the above examples were obtained by the aid of a four-place logarithm table and hence the fourth figure is probably in error in most cases. The results are, however, sufficient to indicate the comparative values of the different types which was the object in view. It will be observed that so far as efficiency is concerned there is little difference. The shell type gives a few watts dissipation than the core type and the core type with three links is a similar amount better than the two-link type. The comparison is better obtained from the values of H than from the percentage efficiency. A noticeable feature is the very considerable saving of weight and increase of induction density obtained by making the links of unequal section. This involves some loss of efficiency, of course, and the question as to how far it can be economically carried has to be determined by considerations of relative cost of material and energy. Curves showing relative weights and efficiencies for different ratios of section can be easily constructd for any particular type and by aid of these the best form for any particular case can be readily estimated. The last example given illustrates how the dimensions may be calculated for a transformer suitable for cases where the primary is continuously on the leads, but the secondary only loaded for a part of the day. The section may, of course, be made unequal in this as in the other cases with advantage as to weight, but possibly with loss of efficiency. It is not, however, essential to economy that a transformer for this purpose should have a smaller iron than coil section. The controlling elements are the induction density and the actual volume of the iron. A transformer of given capacity having the iron section greater than the coil section may have less volume of iron in it than one of the same capacity with equal sections. The sections change shape and the whole volume may become smaller with a sacrifice of efficiency. As indicated above, however, the all-day efficiency may be increased, although the full-load efficiency is diminished.

The capacities of the transformers discussed above have been estimated from the load which gives equal iron and copper losses. In most cases such a transformer will carry a large overload for a short time with safety. The radiating surface will, of course, be too small for continuous use on overload unless artificial cooling is resorted to. When oil cooling, for instance, is used, at least one and a half times the heat can be carried off for the same temperature. A transformer designed for air cooling should not be used with oil and simply loaded higher. A new design should be worked out using the proper value of s in the equations.

The form of link assumed in the above discussion is rectangular with sharp corners. Using the same notation the following modification may be given:

(1) *Two-Link Type.*—(*a*). Links with corners rounded to radius a and a_1:

$ab = A$ $\qquad$ $a_1 b_1 = A_1$

$l = 2(a_1 + b_1) + \pi a$ $\qquad$ $l = 2(a + b) + \pi a$

$$\frac{A_1 + \frac{\pi}{4} A}{A_1} = \frac{b_1 + \left(\frac{\pi^2}{4} - 1\right) a_1}{b_1 - a_1}$$

$$\frac{A + \frac{\pi}{2} A_1}{A} = \frac{b + \left(\frac{\pi^2}{4} - 1\right) a}{b - a}$$

When $A = A_1$,

$$\frac{b}{a} = \frac{\pi}{2} + 1 = \frac{b_1}{a_1} \qquad a = a_1 \qquad b = b_1$$

(*b*) Links with the edges of the sections and ends of the links both semicircles:

$$A = a(b - a) + \frac{\pi}{4} a^2 \qquad A_1 = a_1 (b_1 - a_1) + \frac{\pi}{4} a_1^2$$

$$l = 2(b_1 - a_1) + \pi(a + a_1) \qquad l_1 = 2(b - a) + \pi(a + a_1)$$

$$\frac{b}{a} = \frac{A_1(\pi - 3) + \frac{\pi}{2}A}{A_1} \qquad = \frac{(\pi-3)\{b_1 - (\pi-3)a_1\} + \frac{\pi}{4}a_1^2}{b_1 - (\pi-3)a_1}$$

$$= \pi - 3 + \frac{\pi^2 a_1}{4\{b_1 - (\pi-3)a_1\}}$$

$$\frac{b_1}{a_1} = \frac{A(\pi-3) + \frac{\pi}{2}A_1}{A} \qquad = \pi - 3 + \frac{\pi^2 a}{4\{b - (\pi-3)a\}}$$

When $A = A_1$,

$$\frac{b}{a} = 3\left(\frac{\pi}{2} - 1\right) = \frac{b_1}{a_1} \qquad a = a_1 \qquad b = b_1$$

(2) *Three-Link Type.* (*a*) The corners rounded, but section of links rectangular. Let *a*, *b*, *A* and *l* refer to double-link:

$$ab = A \qquad a_1 b_1 = A_1$$

$$l = 2(a_1 + b_1) + \frac{\pi}{2}a \qquad l_1 = 2(a + b) + \pi a_1$$

$$\frac{b}{a} = \frac{A_1 + \frac{\pi}{4}A}{A_1} \qquad = \frac{b_1 + \left(\frac{\pi^2}{8} - 1\right)a_1}{b_1 - a}$$

$$\frac{b_1}{a_1} = \frac{A + \frac{\pi}{4}A_1}{A_1} \qquad = \frac{b + \left(\frac{\pi^2}{4} - 1\right)a}{b - a}$$

(*b*) In the core type the edges of the section of the iron link may be made semicircles while the sections of the coils are rectangular:

$$A = ab \qquad A_1 = a_1(b_1 - a_1) + \frac{\pi}{4}a_1^2$$

$$l = 2(b_1 - a_1) + \pi\left(a_1 + \frac{a}{2}\right) \qquad l_1 = 2(b - a) + \pi a_1$$

$$\frac{b}{a} = \frac{A_1 + \frac{\pi}{4}A}{A_1} \qquad = \frac{b_1 + \frac{\pi}{4}\left(\frac{\pi}{2} - 1\right)a_1}{b_1 - \frac{\pi}{4}a_1}$$

$$\frac{b_1}{a_1} = \frac{\pi}{4} \cdot \frac{A + 2A_1}{A} \qquad = \frac{\pi}{4} \cdot \frac{b + \left(\frac{\pi}{2} - 1\right)a}{b - a}$$

When $A = A_1$ the ratios $\frac{b}{a}$ and $\frac{b_1}{a_1}$ become

$$\frac{b}{a} = \frac{\pi}{4} + 1 \qquad \frac{b_1}{a_1} = \frac{3}{4}\pi$$

Other modifications may be readily obtained and the values of these ratios in terms of the corresponding volume or section ratios expressed by means of curves like those given in Figs. 2 and 4, but sufficient has probably been given to illustrate the method of proceeding.

The Braun Tube in the Study of Alternating Currents.

In a paper read before the Russian Physico-Chemical Society, Prof. A. Petrovski described an application of the Braun tube to the study of alternating current. The Braun tube is from 2 to 3 cm. in diameter, carrying at one end an enlarged cylindrical part 10 to 15 cm. in diameter and 10 to 30 cm. long. In this enlarged portion is a plate placed perpendicular to the axis of the tube, the surface of which is coated with a fluorescent substance. At the opposite end of the tube, in the narrow part, is a small aluminum disc which is also perpendicular to the axis. The disc is fixed on a platinum wire soldered into the end of the tube. During operation the wire is connected with the negative pole. In another part of the tube is a second terminal, which connects with the positive pole. After a vacuum has been formed in the tube, the aluminum disc emits the well-known radiation characteristic of the Crookes tube, which is directed along the axis of the tube. Midway in the narrow portion is fixed a diaphragm which allows only the central part of the beam to pass. The latter then crosses the wider portion or bulb, and falls upon the fluorescent screen, producing a small blue spot.

The beam has the well-known property of being deflected in one side under the action of the magnetic field, like a wire carrying a current. If the tube is in the horizontal position and the magnetic field is vertical, the beam will be deflected in the horizontal sense, and the spot of light on the screen will be deflected to the right or left, according to the field's direction. If, however, the field is horizontal, the spot will be displaced up or down. Such displacement may be considered as proportional to the intensity of the field. If the intensity of the field be varied according to the time, the shifting of the spot will follow such variations, and the distance of the spot

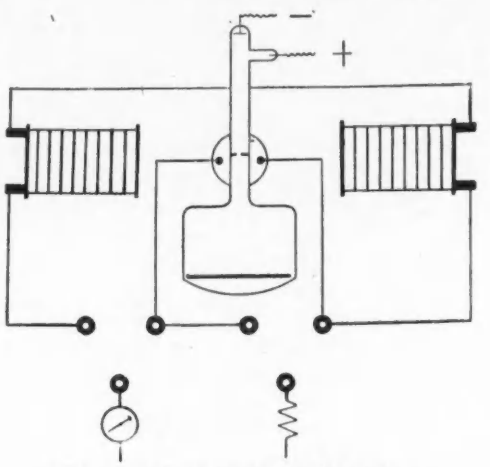


FIG. 1.—ARRANGEMENT OF CIRCUITS.

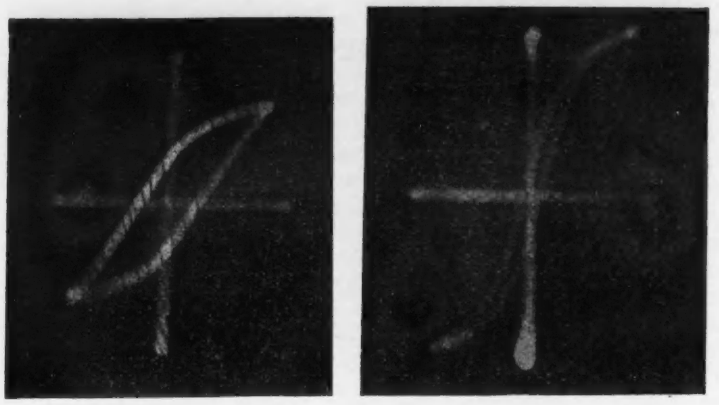
from the center of the screen is considered as proportioned to the field strength at a given moment. Where a solenoid is used to produce the magnetic field, the deflection of the spot is likewise proportional to the current strength in the coil at any given instant.

Owing to these properties the Braun tube can be used to advantage in the study of variable currents and has a great practised value for observing alternating-current phenomena. In general practice there are three main phenomena of alternating currents which are to be studied, namely, hysteresis, phase difference and rotating field. Each of these cases was examined in turn.

To study the phenomena of hysteresis with the Braun tube, the arrangements of circuits shown in Fig. 1 was used. Around the tube are placed three solenoids. The first of these is placed above or below the tube and perpendicular to its axis. The current in this coil creates a magnetic field which causes the spot of light to take a horizontal movement. The two other coils are placed horizontally on each side of the tube, as shown, and the current flowing in them gives the spot a vertical deflection. The latter coils are connected differentially, so that in the normal case their magnetic action is opposed, and the effect which one of them would exert on the spot is annulled by that of the second. The tube can thus be placed in such a position that the action of the horizontal coils is mutually destroyed. But if in one of the coils is placed a piece of the iron to be experimented with, the action of the latter, by changing the field, gives the spot a vertical direction. The deflection of the spot from its normal position will measure the value of the magnetic induction in the sample at any instant. This corresponds to the ordinate of

the hysteresis curve, as usual. As to the third, or upper coil, it produces a horizontal deflection of the spot which at each instant will be proportional to the current flowing through it.

The three solenoids are all connected in series, so that the same



FIGS. 2 AND 3.—HYSTERESIS CURVES.

current which gives the horizontal movement to the spot also produces the magnetization of the sample. The horizontal deflection represents the value of the field strength at any given time or the abscissa of the hysteresis curve. When the current flows through the two sets of coils in series, the spot will take a movement such

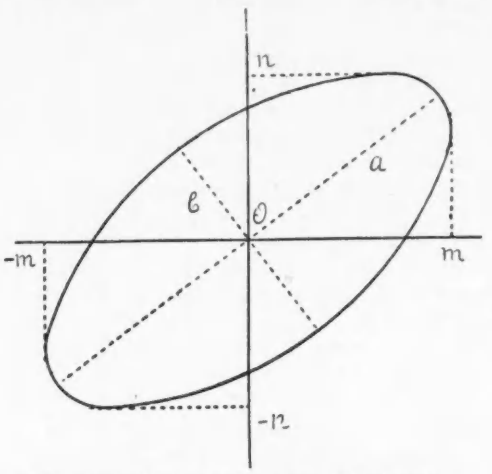


FIG. 4.—RESULTANT OF PHASE DIFFERENCE.

that the ordinates and abscissæ will correspond to those of the corresponding points of the hysteresis curve for the sample, and the fluorescent screen will show a hysteresis curve which will have the same appearance as the usual curve plotted from measurements. The arrangement of circuits which is here adopted allows of throwing the current on the three coils in series, or on the top or side coils alone, so as to check up the action of either set upon the spot. Each of the coils should be placed with its axis perpendicular to that of the tube, so that the axes will cross in front of the central diaphragm. The size of the wire used in the solenoids and also the number of turns are chosen according to the current strength which is used. The light which is emitted by the fluorescent screen is of a high active quality, so that the curve can be photographed without difficulty on a short exposure. The camera should be focused beforehand upon some well-defined object, such as a lighted candle.

In Figs. 2 and 3 are shown photographic reproductions of hysteresis curves which were obtained in this way. The first curve is

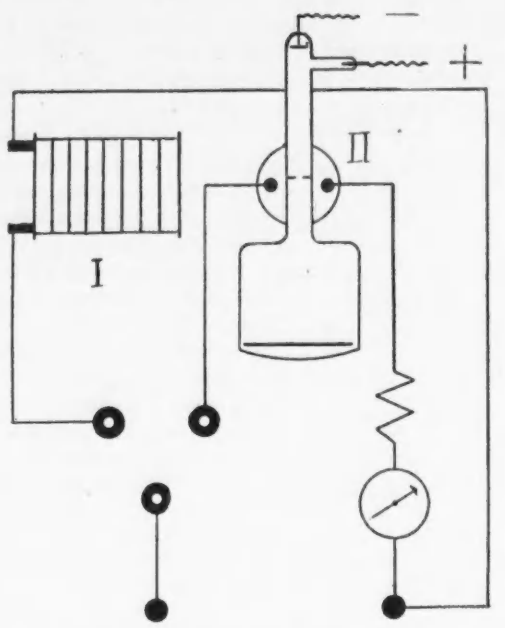
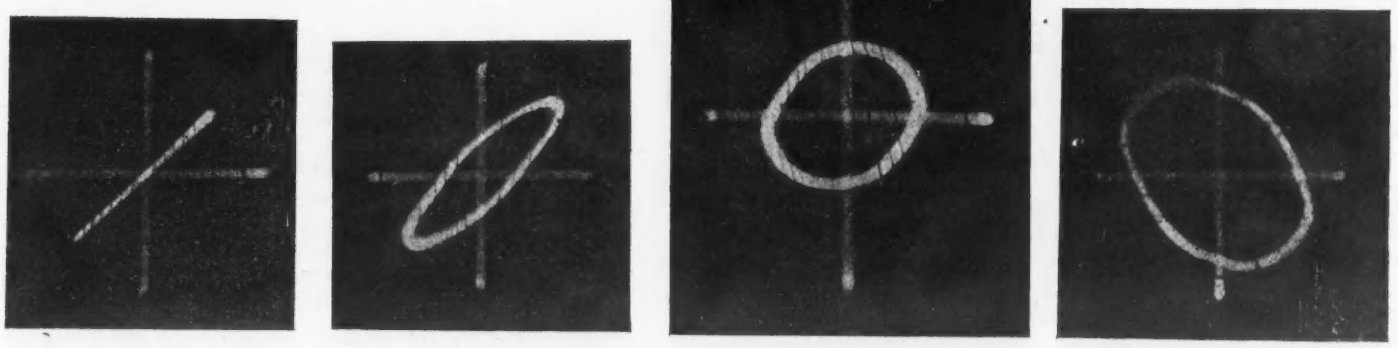


FIG. 5.—MEASUREMENT OF PHASE DIFFERENCES IN ALTERNATING CIRCUITS.

that of a hard file-steel, while the second is the curve of an iron of bad quality. The photographs were taken without enlargement on a plate of average sensitiveness. The tube was supplied from a static machine having two discs of about 60 cm. diameter. The plate was given an exposure of about 1 minute in order to obtain the curve itself. To obtain the lines corresponding to the axes, about 10 seconds is necessary. It should be noted that in tracing the hysteresis curve the axis of abscissæ should not be drawn directly from the curve, but the abscissæ are to be diminished in each case by the value of the so-called "demagnetizing force." As the apparatus does not give this correction automatically, it should be introduced when drawing the curve from the above data.

The use of the Braun tube with the present arrangement gives an easy method of determining the angle of lag between current and electromotive force in an alternating-current circuit, which is in general not easy to measure. In this apparatus the angle of lag, ϕ, is found by the superposition of two oscillatory movements. If we suppose a point which is traveling under the influence of two combined and synchronous impulses, the first in the horizontal and the second in the vertical plane, the resultant of the two movements will be a closed curve. If we use two oscillatory movements, such as a harmonic or sinusoid, it is shown theoretically that the resultant formed by adding their movements will be a sraight line in case there is no difference of phase between the two. Should the phase difference have a certain value, ϕ, the resultant takes the form of an



FIGS. 6, 7, 8 AND 9.—PHASE DIFFERENCES IN ALTERNATING CIRCUITS.

ellipse whose proportions depend mainly upon the value of ϕ. See Fig. 4. It will be remarked that the deflection of the large axis of the ellipse is represented in general by the ratio of the values of the amplitudes, $o\,m$ and $o\,n$. In the special case where $o\,m$ and $o\,n$ are equal, the inclination of the resulting axis of the ellipse is 45°. The ratio of the length of the smaller axis, b, to that of the larger axis, a, gives us the tangent of the angle, ϕ:

$$\tan \frac{\phi}{2} = \frac{b}{a}.$$

These conditions can be applied to the measurement of the angle, ϕ, in the case of alternating currents, in which case we use the system shown in Fig. 5. Near the Braun tube are disposed two coils, *I* and *II*. Coil *I* has many turns of fine wire and takes its current directly from the terminals of the station. Like a voltmeter coil, it does not produce an appreciable effect on the form of the main current. Coil *II* is connected in the main circuit and has a few turns of heavy wire in order to show the current effects. The first coil, owing to its position and the influence of the alternating current which passes in it, gives to the spot an oscillatory movement in a vertical direction. In like manner, coil *II* gives a horizontal movement to the spot. If current is flowing at the same time in *I* and *II*, the spot will take an elliptical movement. If now we displace coil *I* we can easily reach a point where the amplitudes of vibration in the vertical and horizontal sense are equal. Then after measuring the large and small axis of the ellipse thus produced, we find the value for the phase angle according to the above formula. The current flowing in coil *I* equals the number of amperes in the main line. If the ohmic resistance of coil *I* is very high in proportion to its coefficient of self-induction, the current in it will not lag perceptibly behind the e.m.f., so that the relation of the two axes of the ellipse gives the value of the tangent of one-half the angle very closely, representing the lag between the voltage and current waves in the main circuit.

If the resistance of the coil *I* is not very high with relation to the self-induction, the current in the coil will lag behind the voltage wave. The result will not be quite exact, therefore, but it is not difficult to make the proper correction. The curves which are thus obtained can be photographed in the same way as the hysteresis curves. In Figs. 6, 7, 8 and 9 will be observed some of the results which have been obtained by this method. In the first case (Fig. 6) the circuit contains no lag. In the second case (Fig. 7) there is a large self-induction in the circuit. Fig. 8 shows the effect when the self-induction is increased by putting an iron core into the coil. In the last experiment, Fig. 9, the ends of the circuit are open and connected across a condenser of large capacity. As in most cases the alternating-current waves have not an exact sine curve, the resulting form which the spot of light traces is not always a perfect ellipse.

In general the composition of two harmonic oscillatory movements gives an elliptical curve, as above considered, but in the particular case where the amplitudes of oscillation are equal and the difference of phase 90°, a circular form is produced. In like manner, the addition of three harmonic oscillatory movements can give a circle when the amplitudes of all the oscillations are equal and the phase difference is 120°.

The present system allows of investigating the conditions of the rotary field, such as is produced by these circuits spaced 120° apart, in a very satisfactory manner. It is possible to find out whether the rotary field is produced under the best conditions of regularity, which is so important for the good working of three-phase motors and is essential to prevent a loss of energy.

The apparatus for studying the rotary field is disposed on the same lines as the above, using three similar coils ranged around the tube. The axes of the coils are, as before, perpendicular to the axis of the tube, and the coils are spaced at 120° around this axis as a center. The wire of which the coils are wound is heavy enough to allow of introducing each of the coils into one of the phases of the current to be studied. On sending current into the circuit, the spot takes a circular movement; and if there are any irregularities under these conditions, they are shown by the appearance of the circular curve.

The experiments which have been carried on by M. Petrovski have given many interesting curves, and the method recommends itself by its simplicity and the satisfactory results which may be obtained with it in the study of alternating-current phenomena.

Annual Convention of the Iowa Electrical Association.

THE Iowa Electrical Association held its fourth annual convention at Des Moines, April 20 and 21, 1904. President D. F. McGee, of Red Oak, called the first session to order Wednesday morning, and introduced Mayor Mattern, of Des Moines, who welcomed the convention to that city. President McGee then made a brief address, in which he said that members and other central station men over the State were now learning that the Iowa Electrical Association was of great benefit to the central station men of the State. The station managers who never leave their home towns to learn what is being done in other places and to confer with other central station men—as they are able to do in an association of this kind—soon get into a rut, which is a great detriment to their business. The facilities for asking questions about particular points, which are afforded by the Iowa conventions, give the central station man the easiest means of getting out of such a rut.

Secretary W. S. Porter, of Eldora, in his report, said he had received letters from Missouri and Nebraska men, expressing a desire to attend the convention, and he had told them they would be welcome. It might be well for the Association to consider whether such men should be admitted merely as guests or given some rights of membership. He referred also to a movement among the electric railway men of the State to form an organization, a meeting for which purpose was to-day being held. He recommended that a committee be appointed to confer with the electric railway men and to consider whether it would be advisable for the electric railway and electric light men to join together in an association, or whether the two allied interests should be kept apart.

The treasurer's report, by Treasurer Rufus E. Lee, of Clarinda, showed a balance of $68 in the treasury. A ballot taken for the election of a nominating committee resulted in the election of W. J. Greene, of Cedar Rapids; W. S. Carson, of Iowa City; Austin Burt, of Waterloo; M. W. Hovey, of Marshalltown; W. H. Grover, of Cherokee; Prof. George W. Bissell, of Ames, and Robert Ferris, of Eldora.

CENTRAL STATION ACCOUNTING.

Robert Ferris, of Monmouth, Ill., owner of the Eldora electric light plant, gave a talk on station accounting, demonstrated by the various blanks which he employed in his central station business at Monmouth, Ill., and Eldora, Iowa. He requires every man in the employ of the company to make out a daily time sheet, showing the number of hours work on different jobs. The distribution of expense among the different accounts is made at the office. The only bookkeeping responsibility on the men is to make out their time sheets correctly. He requires a record to be written of every trouble report that comes in, even if the man answering the telephone goes himself immediately to remedy the trouble. In such a case the man upon receiving notice of trouble from a customer would make out a trouble slip, file it on the hook, and when the trouble had been fixed return to the office and make memorandum on the slip to that effect. In this way there is no danger when several reports of trouble come in at the same time that one of them will be overlooked or forgotten. These slips form also a record which can be referred to in case customers complain of interruption of the service at the end of the month when paying bills. The system of records devised by Mr. Ferris was founded upon the form of report required by the Massachusetts commission.

He outlined briefly the Massachusetts laws, which provide for the safeguarding of investments in public service corporations. Competition in the electric lighting business in a Massachusetts town cannot be started at random. It must be shown that existing companies are not giving the service that should be given, or that the rates are unreasonably high. If the city undertakes the construction of a municipal plant, it requires a vote of the people and a vote of the council.

Mr. Ferris makes it a practice to invoice a customer's equipment every year, so as to know what is connected with the station. At Monmouth, after taking charge of the plant, it had been found, upon investigation, that under the flat rate system of selling current each company was delivering about half of a kilowatt-hour per day per customer, for which it was receiving 3.7 cents per kilowatt-hour, or less than the cost of production. A change was made to selling current by meter, and a well-worded pamphlet with a few pages was prepared by Mr. Ferris, announcing the change. This was mailed to the customers, followed by a personal visit to each. The

rate is 20 cents per kilowatt-hour up to an amount equivalent to 40 hours burning of the maximum number of lights turned on during the month. He explained why he considered a discount based on the maximum demand much fairer than a discount based simply on the amount of current used. For example, a small customer with a low maximum demand and using his lights a great many hours a day, would produce more revenue for the company than a large demand customer, using lights only a short time each day. If the discount were based simply on the total amount of energy consumed, the customer with a large number of lamps running a short time each day might get a better discount than the customer with the small maximum demand, who burned his lights continuously.

Referring again to the trouble slips, he said that men were required to record all of the time put in whether engaged on any specific work or not. Men kept for answering emergency and trouble calls put down the time doing nothing in the office along with the rest. In this way the manager could see when he could take a man off emergency trouble work and put him on other work. All the time put in by the men must be accounted for in some way. The system of bookkeeping was simply a double-entry system, in which everything was balanced.

UNIFORM ACCOUNTING.

Wednesday afternoon the discussion of central station accounting was continued by the reading of a paper by Austin Burt, of Waterloo, on "Uniform Accounting." Mr. Burt, in presenting his paper, said that he realized that 75 per cent. of the central stations in Iowa were in towns of less than 5,000 people. In such stations one man must be superintendent, bookkeeper and electrician. Any elaborate systems of bookkeeping are out of place. He considered it a question how much value the set of blanks he would present would be to the small companies. The question of bookkeeping forms for large stations he considered was taken up in a very complete way before the National Electric Light Association in 1903, by W. M. Anthony, and before the same body by Lieut. J. B. Cahoon, in 1900.

He described his power station log, which was made up by the engineer. The engineer plotted the load curve directly on this log. He considered it better for the engineer to do this than to add it to the bookkeeper's work, and further, a graphic load curve was of more interest to the power station operating man than the mere figures. On this log also are provided spaces, in which, by ruling horizontal lines, corresponding with the load curve, the time of operation of each generator can be seen at a glance. This gives an idea as to whether station machinery is being run as fully loaded as it should be. As to the value of watching this point, Mr. Burt cited the experience in his station, where a few years ago the load factor of the station or the percentage of the average load to the machinery operated, was 13 per cent. for 24 hours. That is, only 13 per cent. of the capacity of the machinery was being used as an average for the 24 hours. The load factor was now about 80 per cent. The coal consumption per kilowatt-hour cost 2.75 cents formerly, and is now 0.9 cent. This change has been brought about mainly by proportioning the generators operated to the load, and ceasing to operate generators for many hours very much underloaded. A small engine was purchased for operation during the hours of very light load. This small unit has proved a very good investment.

As to bookkeeping in connection with the distribution system, that connected with the reading of meters was the most important. He used a small card of a card index system for each meter, each card having space upon it for two years' readings. These cards are arranged in the order which the meter reader will follow on his route, and are given out to each meter reader. He believes in employing responsible men for meter readers, rather than boys. Nothing but the most trustworthy men are employed on this work, so that the company may be sure that each meter has been actually read, and not guessed at, and is furthermore read carefully, so that the customer can have no just cause of complaint or opportunity to say that the company's business was conducted in a slip-shod manner.

He formerly believed in bills showing on their face all the figures in connection with a meter reading, crowding as much onto the bill as possible, giving the last reading, present reading, the kilowatt-hours and the calculation of the discount. In fact, his bills used to contain all the arithmetic of the monthly transaction with the customer. He has come to believe that these figures simply confused the average customer, and he now uses a bill which contains simply the gross bill and the discount which is allowed for prompt payment. He found that there were fewer questions under the present system than under the old system. In adding up the total amount of current sold for the month, he recommended strongly the use of an adding machine. In his case he had been able to make arrangements with a local bank for the use of such a machine. He spoke of two good makes of adding machines, one of which cost $125 and the other $375.

As to time cards, he requires time cards made out on all work and O. K.'d by the foreman in charge of the job. Instead of carrying a ledger account with customers for whom small repair jobs and the like have been done, he uses what is practically a triplicate bill with stub. One bill is sent to the customer, another filed for the use of the collectors, and the third remaining in the book, to take the place of a ledger account. The stub at the bottom of the customer's bill is turned in by the collector with his cash as a memorandum. Mr. Burt also showed the forms he used for stock room and invoice accounts and for general monthly report of the total business.

CO-OPERATION WITH TROLLEY MANAGERS.

At this point L. D. Mathes, of the Union Electric Company, of Dubuque, Iowa, was introduced as a committee representing the electric railway men of Iowa, who were in session at the Kirkwood Hotel at the same time. The street railway men desired a conference with a committee of the Iowa Electrical Association to consider whether it would be advisable for the two branches of work to organize under the same association. Messrs. Burt, Carson and Greene were appointed a committee to visit the railway men's convention. As a result of the conference of this committee with the electric railway men, it was decided by the latter to form a separate organization and to arrange the time of annual convention, so that one day of the electric light convention would overlap that of the electric railway convention of the State. The two associations and those interested in both could, therefore, discuss topics of mutual interest during the one day that the conventions would overlap.

COMBUSTION OF IOWA COAL.

A very practical paper on the "Combustion of Iowa Coal" was read by Prof. George W. Bissell, of Iowa State College, Ames, the data of which should be of much value to those using coal from the Iowa veins.

In response to a question as to the relative heat value of Illinois and Iowa coal, Prof. Bissell said that as far as chemical analysis went, the coals of the two States were about the same. Mr. H. E. Chase said that it required more draft to burn the fine coals, and many steam plants in Iowa did not have sufficient draft, and hence had to burn lump coal. Aside from this, the cheapest coal was the best one to burn as a rule. Mr. Bowers said that in his plant, which burned from 50 to 100 tons of steam coal per day, they found that it took practically as much to do the work with the lump coal as with the slack.

President McGee asked whether an excessive stack was not necessary where a baffle was placed behind a bridge wall as described by Mr. Boyd. The latter said that it was not, and cited an example where the change was made without changing the stack and with a great improvement in the performance of the plant. Prof. Bissell thought that coal should be burned while it was in the furnace and not behind the bridge wall. This discussion ended here and an invitation was read from the Columbia Incandescent Lamp Company, of St. Louis, inviting any of the members who might visit St. Louis the coming summer to go through the Columbia lamp factory and see the processes of manufacture.

SCALE INCRUSTATION IN STEAM BOILERS FROM A CHEMICAL STANDPOINT.

Paul E. Bellemy, of Knoxville, Iowa, presented a paper on the above subject, in which he gave a general résumé of the principles of the several ways to attack boiler scale trouble, of scale formation and iron corrosion. One is to send the water to some of the reliable manufacturers of boiler compounds who will analyze it, furnish a proper neutralizing compound and give the quantity required to neutralize the scale. Another method is to employ some disinterested chemical expert to make an analysis and prescribe the kind and amount of reagents necessary to reduce the scale-forming salts to harmless salts. Some boiler compounds were nothing more than well-known cheap reagents colored in some way. In reply to a question as to how to test feed water after it was in the boilers to see whether the treatment was effecting the proper result, Mr. Bellamy said that the best way was to watch the practical result on the boilers.

Mr. Zahm described a method used by him at Mason City for introducing boiler compound in a closed tank located above the suction of the boiler feed pump. He further said that a galvanized-iron pan in the bottom of the boiler was a good thing. This pan is made just wide enough to go through the hand-hole above the bottom sheet and is suspended three or four inches above the bottom sheet of the boiler. The scale and mud settles upon it. Mr. Emory emphasized the necessity of operating a purifying system systematically and carefully. Too much boiler compound or reagent was worse than not enough.

STORAGE BATTERIES IN CONNECTION WITH A CENTRAL STATION.

Edward Reavy, of Davenport, read a paper on the above subject. A small central station, he said, cannot furnish current twenty-four hours of the day because of the light load during daylight and early morning hours, but stations would be able to give twenty-four hours' service with the aid of a storage battery during the hours of moderate load. He described a battery in his station operated in connection with rotary converters. This sub-station supplies power for lighting and railway purposes from the same transmission line, and it is only by the use of the battery that the fluctuations are kept within feasible limits. This battery is kept floating on the line to take up the fluctuations in load.

In the discussion of this paper the question was raised as to the cost of the storage battery. W. Owen Thomas said that the cost of the battery was about $100 per kilowatt at 1 hour rating. Answering some questions as to efficiency, E. L. Draffen said that the efficiency on this kind of work was 96 to 97 per cent., and that the manufacturers would maintain the battery for 5 per cent. of its initial cost per annum. He called attention to the advantages of using the battery in small direct-current plants, so that the generating machinery could be run for a short time fully loaded, supplying the peak load and afterward charging the battery, leaving the battery to take the light load the rest of the twenty-four hours.

Mr. J. A. White thought the efficiency given for the storage battery by Mr. Draffen was too high. If the battery was floating on the line, taking only the momentary peaks and never being fully discharged, an efficiency of 95 to 96 might be realized. The battery used to aid in carrying the peak load on the station only and discharged fully during the peak each day would probably give about 80 per cent. watt-hour efficiency; 75 per cent. being guaranteed by the manufacturing companies.

ELECTRIC METERS.

George S. Carson, of Iowa City, read a paper which was brief and to the point, on the plan of charging by meter. He condemned the flat rate still in existence in some plants and said that few realized how much the meter has to do with the success of the electric lighting business. The output of the company, which is paid for by the customers, is measured by the meter and, therefore, the earnings of the company are directly dependent upon its accuracy. The early meters were inaccurate, with heavy moving parts, but immense improvement had been made until the modern meter was a fairly satisfactory instrument. Meters should be tested upon receipt from the manufacturer, as their accuracy may have been damaged by their rough usage in transit. After a meter is put in operation it should be tested at regular intervals. The receipts per kilowatt-hour on a flat rate are usually about one-half what they should be. This does not mean that consumers will pay double their former bills when the change is made from a flat rate to a meter basis. Consumers which formerly wasted the current will begin to economize when put on meter, so that the output of the company will be reduced and the receipts on the whole increased.

In a plant which he had tested recently, which operates twenty-four hours per day, and is equipped with new meters throughout, he had found the switchboard output in a given period to be 18,450 kw-hours at the switchboard, and 13,806 kw-hours as measured by the consumers' meters. This represents a loss of 25.2 per cent. between the switchboard and the consumers. He thought the maximum demand system of charging with the aid of a maximum demand meter better than the plan of estimating a customer's maximum demand by the number of lights wired up. The latter system had the effect of restricting a customer in the number of lights he would install, while, if a customer was charged according to the indications of a maximum demand meter he would put in as many lights as he could use in various portions of the house, even though he did not ever expect to use them all at once, and thus his total consumption of energy would be greater than if fewer lights had been wired. This of course was to the company's interest.

Mr. Zahm, of Mason City, cited a case in his experience where 100 meters had been inspected by a company making a specialty of that business. These meters had been running for some time without attention; 97 per cent. of the meters were slow from 7 to 56 per cent. The 3 per cent. which were fast had been struck by lightning, which short-circuited some of the field turns, thus weakening the field and causing the meter to run fast. Now his company had gone over all its meters and established a laboratory for bringing in meters and testing them every six months systematically. Most of the trouble from slow meters is due to charred commutators and injured jewels and tips. He recommended that old jewels removed from meters be saved, as they could be recut after a sufficient quantity had been accumulated, so as to be as good as new, at a considerable price below the new jewels.

In response to a question as to where the 25 per cent. of energy went to in Mr. Carson's case where customers' meters registered 75 per cent. of the energy leaving the station, Mr. Carson replied that he thought 75 per cent. efficiency was considered very good for an alternating-current system, taking into account the line losses and core losses in the transformers.

Mr. Burt said that the results he had obtained in testing a large number of meters at Waterloo also showed that many meters were 55 to 60 per cent. slow. The majority of meters run slow on light loads. He considered the best meter one which could be adjusted accurately for a light load. He brings in his meters for testing. The cost of bringing in meters at regular intervals for testing was at first appalling, but a little calculation of the losses from slow meters showed that it paid.

Mr. Ferris said that at Somerville, Mass., the result of going the rounds of all meters and testing them resulted in 33⅓ per cent. increase in the gross revenue. He figured roughly that the loss of gross revenue would be about 33 per cent. in any station where meters were not tested.

DATA ON STEAM TURBINES.

Mr. J. M. Wilkinson read a paper descriptive of the Westinghouse-Parsons steam turbine and also presented some curves and data on efficiency, much of which has appeared before in these columns. One advantage claimed for this turbine is the large clearance between the moving and stationary vanes, which clearance permits the turbine to be operated without close adjustment. The only wear about such a turbine unit is the bearing wear, and the machine should, therefore, be very durable. Where condensed exhaust is used for boiler feed, the turbine offers pure boiler feed water, free from oil, since there are no valves or pistons which need lubricating. About 38,000 hp of these turbines have been built or are under construction in this country. The list of large turbine units given by him was astounding, even to those who have watched the progress of the steam turbine. He said that in no case had reciprocating engines been installed in plants after Westinghouse-Parsons turbines had been put in.

In response to a request from Mr. Carson to give the performance of a turbine on 120 pounds boiler pressure and 25 in. of vacuum, Mr. Wilkinson cited the nearest case he could find, which was on a 400-kw unit operating on 125 pounds steam pressure and 26 in. of vacuum. With a load of 580 hp the steam consumption was 15.21 pounds per brake-hp-hour. With the load at 457 hp the consumption was 16.36 pounds and at 326 hp the consumption was 17.89 pounds.

In answer to a question as to whether the governor of a turbine could be made to change the speed of the turbine by means of an electric motor controlled from a switchboard as in the case of a Corliss engine where it is desired to operate alternators in parallel, Mr. Wilkinson said that it was possible if thought desirable, but that the change in speed could be easily effected by hand. The cost of the steam turbine unit was given as about the same as that of a reciprocating steam engine unit. When asked for a comparison between the economy of a steam turbine and a gas engine, Mr. Wilkinson assumed that the turbine could be operated with two pounds of coal per hp-hour, while a gas engine would require 11,000 B.T.U. per brake-hp-hour, or about 1¼ pounds of coal. This was giving the gas engine the benefit of the doubt, however. He thought the economy of the gas engine and the steam turbine about the same under the best conditions. It would cost less to install the turbine.

The question was raised whether the reciprocating engine would go out of use. Mr. Wilkinson thought it would in the larger sizes. In the smallest sizes the reciprocating engine would show better economy. Replying to questions as to whether it did not require much greater investment in condenser to give the better vacuum considered desirable with a turbine, Mr. Wilkinson said that the same size of condenser as would be used with a corresponding size of reciprocating engine would give from 1¼ to 2 in. better vacuum with the turbine because of the few chances for air to leak into the turbine. As to spending money on a condenser to secure higher vacuum, that was simply a question as to how much would be gained by the higher vacuum. As more is gained by a higher vacuum on a turbine than on a steam engine, it naturally pays to spend more money in securing this vacuum on the turbine than on the steam engine.

LAMP TESTING.

Thursday morning's session was opened by Prof. L. B. Spinney with his paper on lamp testing. Prof. Spinney referred to the work which had been started at Iowa State College for the benefit of the central station men of the State. For some time the electrical department of this institution, under Prof. Spinney, has been prepared to test incandescent lamps for energy consumption and mean horizontal candle-power for the central stations of the State at the nominal rate of $1 per dozen. Prof. Spinney's paper was in the nature of a report of progress in this work. He said that comparatively few lamp tests by disinterested parties were to be found. Most of the tests heretofore published have been carried on by lamp manufacturers. The best efficiency of lamp to use is likely to be given too little attention. Whether a high or low efficiency lamp should be used will depend very much upon the cost of the current. If a station is operating with water power, so that the cost of supplying a few extra watts per lamp is small, a low-efficiency lamp may be advisable. In general, a high efficiency is desirable. There is an appreciable difference between lamps not only of different manufactures, but of the same make. He advocated lamp testing, at least in the rough, for all moderate-sized stations. He presented, by way of introduction, several curves characteristic of the behavior of incandescent lamps in general, showing how the resistance and watts per candle-power increase with age while the candle-power and efficiency decrease. He brought out the fact, sometimes forgotten, that the efficiency of a lamp depends on the voltage at which it is operated, and it may be made high or low efficiency by simply varying the voltage. He presented a number of shot gun diagrams showing the life and efficiency of 16 makes of lamps sent him for test. A large number of these lamps did not come within the efficiency and candle-power for which they were rated. While many of the results were not bad in themselves, they showed improper rating of lamps by the manufacturers. In response to questions as to whether results shown by Prof. Spinney were usual or simply exceptional cases, Prof. Spinney said that they were usual. Prof. Spinney advised the practice of making a rough photometer and wattmeter test of all lamps by the average central station, these tests to be supplemented and standards checked by laboratories with better testing facilities.

Mr. Carson said there was no trouble in getting lamps which would correspond with the guarantee when such testing was done by a central station company. Mr. Boyd said that he did not know of a single manufacturer sending out lamps of nominal 16-cp which would not vary at least 1 cp either way from this rating. No central station operated with exactly the same voltage at all points of the system. The advisable thing to do was to place lamps at the points best suited for their voltage. He considered that a voltmeter, indicating wattmeter, and a photometer were essential in the operation of any central station. These three instruments would cost about $250, and would prove a good investment.

SERIES ARC STREET LIGHTING.

M. A. Harrison, of Osceola, described a series alternating-current arc lighting system which his company had installed. This system is operated by two-phase, 1,100-volt generators. It has three circuits of 15, 20 and 25 lamps, respectively. He described the Western Electric regulator used to maintain constant current on these circuits. He said that the series enclosed arc lamp required more care in trimming than a series open arc. They had found that when the trimming was done by an inexperienced man there was likely to be trouble from nicking the inner globe so that air would be admitted and the life of the carbon shortened. A careless man would also fail to get carbons in line as they should be. They had found the average life of carbons to be 80 hours, although it was claimed that 120 hours could be run on one trimming. This was not realized in practice. Occasionally lamps would not pick up when the current was turned on to a circuit because of the high resistance of the contact between the carbon tips. This trouble could be overcome by momentarily increasing the current at starting. The cost per carbon on these lamps was 3½ cents per carbon and two 11/12 carbons were consumed per month per lamp. He favored metering current for street lighting in order to settle disputes regarding the number of hours lamps were out, as the city authorities were likely to claim more than the actual time.

MULTIPLE STREET ARC LIGHTING.

Rufus Lee, of Clarinda, read a paper on "Multiple Alternating Current Arc Lamps for Street Lighting." He stated his objections to the series system of arc lighting, namely, the high potential of the lamps, and the consequent danger to trouble men when fixing lamps, and the fact that a broken wire anywhere in the series circuit would put out the entire current. Consequently, he had installed alternating current enclosed arcs for street lighting, operating from constant-potential transformers. He had four circuits devoted to this work and they were operated from a two-phase generator, the arc circuits being provided with throw-over switches, so they can be placed on either phase. He had his arc lamps on a three-wire secondary distributing system, but did not advocate this, and was changing to a two-wire secondary system. In a few cases residences and incandescent lights were operated from the same secondary circuits, where for some reason it might not be feasible to have a regular commercial circuit.

Mr. Burt said that one thing about the multiple system of street arc lighting which he liked was the possibility of running different sizes of arc lamps. That feature he considered undoubtedly an advantage in some places.

EXPERIENCE WITH NERNST LAMPS.

Mr. G. C. Gardner, of Mt. Vernon, Iowa, had prepared a short paper on this subject, which was read by Mr. Greene. The experience of this company with Nernst lamps, which covered one year of operation, has been very satisfactory. These lamps require more attention than incandescent lamps, but his experience had shown that the lamps do all that is claimed for them in the printed matter of the manufacturing company. The quality of the light approached daylight, which made it a good lamp for dry goods stores. His customers liked it both on account of quality and the amount of light obtained for the money.

Mr. Greene said that his company was now supplying current for between 500 and 600 Nernst glowers. The experience had been satisfactory and customers were beginning to ask for the Nernst lamp. With the voltage regulation which they were now maintaining on the system, the maintenance of the Nernst lamps was about 0.6 cent per kilowatt-hour supplied to the lamp. Very close regulation was necessary.

Mr. Burt said that his experience with the Nernst lamp had been exceedingly varied. In a certain Catholic church, where it had been desired to install electric light without the expense of chandeliers, three six-glower lamps had been installed. The church people were very much pleased with the lighting of the church and delegations from other Catholic churches in the State had been inspecting the lighting. In his experience the greatest difficulty with the Nernst lamp is the burning out of the heaters, usually caused by neglect on the part of the customer to turn off the lamp when the glowers are burned out. The Nernst lamp is a good thing with which to compete with the Humphrey gas arc.

Mr. Greene said he was putting in three-glower Nernst lamps to do the same work as a four-burner Humphrey gas arc. The three-glower lamps consumed 270 watts.

Mr. Innes, of Eagle Grove, brought out the fact that a voltage much above normal for a short time would soon ruin the glowers, and that trouble in voltage regulation if the voltage was allowed to get high for a short time was likely to be followed by an unusual number of repairs on Nernst glowers. The Nernst lamp would stand about the same voltage variation as a 3.1-watt incandescent lamp.

Mr. Burt said, for the consolation of the electric light men, that the repairs on Humphrey gas arcs were by no means small, and

that his company, which also owned a gas plant, charged $1 per month maintenance on one Humphrey arc installed for a customer and 50 cents each for additional arcs.

RENEWED INCANDESCENT LAMPS.

Mr. J. A. Innes, of Eagle Grove, gave a short paper on his experience with renewed incandescent lamps as compared to new lamps. While not presenting any definite figures, he said that the renewed lamps were similar in performance to many of the new lamps tested by Prof. Spinney, the performance of which was given in Prof. Spinney's paper. The cost of these lamps was about half that of new lamps. In discussing this paper, Mr. Innes said that a good photometer for rough testing could be purchased for about $14.

INCREASING THE OUTPUT OF LIGHTING PLANTS.

"The Best Method of Increasing the Output of Lighting and Power Plants" was the subject of a short paper by Mr. A. W. Zahm, of Mason City. He suggested a number of uses for electric current during hours when the lighting load is small, such as power for city and private pumping, the operation of refrigerating machinery, the use of heating devices and sign lighting. He considered the maximum demand system of charging good, because it tended to increase the consumption by long-hour customers. He made a low rate for opera houses and churches, because their maximum demand did not come at the time of heaviest load on the station, and in the case of opera houses, failure to make such a low rate might mean the installation of an isolated plant. He considered electric elevators an undesirable class of customers, and preferred to sell current to operate a pump for hydraulic elevators. He dwelt at length on the encouragement of sign lighting, mentioning the fact that very attractive signs are now made with low consumption of energy, and that in addition to local merchants, outside corporations sometimes spend considerable money in the illumination of large signs advertising some food product or the like. Thawing water pipes in cold weather was also a source of small revenue. Where a company mailed bills to its customers, it was a good plan to enclose a folder advertising some new electrical device with each bill each month.

On Thursday afternoon the discussion of Mr. Zahm's paper was taken up. The question was asked whether it would pay a central station to add a refrigerating plant. Mr. Zahm said that at Mason City there is a cold storage plant which also manufactures some ice for the use of the company owning the cold storage plant, in supplying its refrigerating cars. He did not advise central stations to go into the refrigerating business with ice as cheap as it is in Iowa, but private refrigerating plants made good customers. The manufacture of ice could only be engaged in profitably in connection with a cold storage plant where the investment in refrigerating machinery had already been made. He arranged with his cold storage plant customers that they should not operate during the winter peak load. These plants afford a continuous load in summer. Mr. McGee said that he had made a cold storage plant a very low rate with the understanding that he could shut them off during the peak load.

Mr. Carson asked how it would be possible to distinguish between store and sign lighting in rates. Mr. Zahm said that low-rate sign lighting should not be on at the peak, whereas store and store window lighting is. Mr. Burt thought that church lighting should only be the very highest rate. For example, a church might have as high as 300 lights, all of which are liable to come on at one time and to provide for which the company must keep a large investment idle except for the few hours the church was lighted. Mr. Carson agreed with Mr. Burt that the lighting bills of a church of this kind would not pay interest on the investment necessary to supply it. Mr. Zahm replied that the peak load is usually off by 7.30 P.M. Churches and opera houses are not fully lighted until about 8 P.M. He had an opera house using 650 lights in Mason City, which had never been turned on during the peak.

Mr. Greene figured that church lighting would come on during the peak of the residence load, but that, on account of the church attendance fewer lights would be used in residences, so that one would partly offset the other. Mr. Burt said that his company had earned about $625 the past winter thawing out frozen water pipes. This was done with the aid of a 10-kw transformer. The charge was $10 for the first hour on the job and $5 per hour after that. This charge was based on the value of the company's "professional services." It would cost several times that amount to do the job any other way. Mr. Smith, of Ackley, told of a man who had purchased a plating dynamo and a gasoline engine, which had been placed on a wagon and used to supply current wherever needed for thawing out water pipes. W. Owen Thomas said that considerable work in thawing out water pipes had been done at Sault Ste. Marie the past winter. They had a rough rule of using ½ volt per ft. of 2-in. pipe, increasing the voltage inversely as the square of the diameter and directly as the length.

OPERATION OF SINGLE-PHASE MOTORS ON LIGHTING CIRCUITS.

A paper on the above subject by Mr. W. A. Layman and Mr. Sparrow, which has previously appeared in the technical press, was read, in the absence of the authors, by Mr. W. Owen Thomas. This paper brought out the advantages of using the Wagner type of single-phase alternating-current motor on single-phase circuits. The curves of starting current and power given, showed the motor to be able to start with normal running current at considerably more than normal torque. These were from tests made by the Chicago Edison Company. Curves of cost prepared by the same company showed the cost of installation of the smaller sizes of single-phase motors to be much less than the cost of the same size polyphase motors.

After the reading and discussion of this paper Mr. Thomas, at the request of the association, gave a talk on the electric power development at Sault Ste. Marie, Mich., of which he is the engineer.

The question box, of which Mr. W. J. Greene, of Cedar Rapids, was editor, was presented to the Association in pamphlet form. A vote of thanks was passed to the Des Moines City Railway Company for the use of its car for a trip Thursday noon and to the supply men for the smoker tendered to the members Wednesday evening. The Association then went into executive session and elected the

PRESIDENT W. L. BOWERS.

following officers for the ensuing year: President, W. L. Bowers, Davenport; vice-president, Austin Burt, Waterloo; secretary, W. S. Porter, Eldora; treasurer, Rufus E. Lee, Clarinda. Executive Committee—W. J. Greene, of Cedar Rapids; W. S. Carson, of Iowa City, and A. W. Zahm, of Mason City. The next meeting place will be Dubuque, Iowa, in April, 1905.

Telephony In Nova Scotia.

Mr. W. R. Holloway, United States Consul-General, makes an interesting report on telephony in Nova Scotia:

"A new line of long-distance telephone, with 292 miles of copper wire, has been opened between Halifax and Sydney, the offices being equipped with the latest improvements. The reports of the Bell Company show that in the Province of Nova Scotia there is one telephone in use for every 88 inhabitants. In the city of Halifax there is one to every 27 persons, while in other towns the proportion is between 20 and 30. The report of the general manager of the Nova Scotia Telephone Company shows 790 miles of poles for their long-distance lines and 2,246 miles of copper wire. The total mileage of telephone wires in the Province is 7,136, and of posts is 791.

"The number of telephones in the Province is 3,260, of which 1,801 are in the city of Halifax. Last year the company transmitted 14,000,000 messages. The long-distance lines unite Truro, Amherst, Bridgewater, New Glasgow and Windsor-Sydney.

"The average number of calls per day, per telephone, in Halifax, is 11, compared with 7½ under the old system. Halifax answers daily 18,000 calls; the average per telephone is only 10, although some instruments go as high as 150 calls a day. The rates for conversations of three minutes between Halifax and points in Cape Breton country are each $1.25 in the daytime and 65 cents at night, between 6 P. M. and 8 A. M."

April Meeting of American Institute of Electrical Engineers.

At the regular monthly meeting of the American Institute of Electrical Engineers held on Friday evening, April 22, two papers were presented, one by Mr. David B. Rushmore on the "Mechanical Construction of Revolving-field Alternators," and another by Messrs. H. M. Hobart and Franklin Punga, entitled "A Contribution to the Theory of the Regulation of Alternators."

Mr. Rushmore, in his paper, gave information in detail concerning the construction of revolving-field armatures, under the head of yokes, laminations, clamps for laminations, slots, armature winding, ventilating space blocks, shields, rims, arms, hubs, field coils, pole shoes and collector rings. The paper, which is profusely illustrated, does not admit of abstract, but in its original form will be found of much value as presenting the present status of the construction of revolving-field alternators, with a discussion of the various differences in design.

The paper by Messrs. Hobart and Punga described a new method for the predetermination of the characteristic curves of alternators with special reference to regulation. The paper is accompanied by numerous curves, and abundant data are given for use in applying the method. The authors start with the assertion that the change in the voltage of a constantly-excited generator when its load is varied in nature or amount, is chiefly occasioned by the magnetic flux set up by the current in the armature winding and linked with the turns constituting the winding. This flux is classified according as the flow in one or the other of three paths as follows: In the first path the lines never emerge from the armature and consist of those which cross the armature slot from side to side, and those which are linked with the end connections. In the second path the lines emerge from the armature and cross the air-gap toward one end of the pole shoe, and after passing along the pole shoe return across the air-gap to the armature from the other end of the pole shoe. In the third path the lines, after emerging from the armature, traverse successively the air-gap, pole shoe, magnet core, yoke, adjacent magnet core and pole shoe; and after again traversing the air-gap re-enter the armature.

On the basis of this analysis the authors proceed to develop a theory, and a table is given which shows a close agreement between calculation and experiment in the case of seven single-phase and eleven three-phase machines.

The paper in referring to the specification of regulation, says it is exceedingly difficult, even with the best wattmeters and other measuring instruments, to demonstrate the presence or absence of a slight difference of phase or to measure it, although such a slight phase difference has a great influence on the regulation. Furthermore, for tests with unity power factor a certain fall in speed is difficult to avoid in throwing on the load. It is stated that a very desirable step would, therefore, be the introduction of the percentage inherent regulation at zero power factor as an important criterion of design, and the paper discusses a number of factors which in this case it would be necessary to specially consider since they may affect the inherent regulation at unity power factor without impairing the inherent regulation at zero power factor.

The discussion of papers was participated in by Prof. C. A. Adams and Messrs. B. A. Behrend, W. L. Waters, Gano S. Dunn and Dr. F. A. C. Perrine. Prof. Adams criticised the use in the paper of Messrs. Hobart and Punga of the average in connection with leakage reactance. He took exception also to the statement that similar methods previously suggested did not yield good results, and referred to a method which he had devised which gives quite as good accuracy as that of the authors'. In this method the whole magnetomotive force is considered as one, and its space direction, not the phase, is employed in such a manner that it takes account of the shift from the central full-phase position. The chief approximation is the position of the field magnetomotive force and the armature magnetomotive force. Recently the method was applied to a closed-coil ring armature in which the three-phase connection gave a three-belted winding, a single belt occupying 120° instead of 60°, as in the ordinary three-phase machine. This makes the application of the armature magnetomotive force more complicated, but the results came out closely.

Mr. B. A. Behrend said that the problem considered is so complex and intricate and there are so many factors to be taken in account, that it does not admit of general solution. He criticised severely the specification of regulation on a power factor of unity. In large machines a unity power factor can never be obtained. If tested with a water rheostat, a leading current is introduced owing to the electrostatic capacity of water resistance. He considered that the regulation should be determined at zero power factor. By using two machines, one as a synchronous motor and one as a generator, this can be done, and it can also be done by splitting the field with perhaps less accuracy. Mr. W. L. Waters, in a communication, criticised some of the assumptions of the authors, particularly with respect to the factor of cost magnetization. He believed that Mr. Hobart's method, if considered an empirical method, will probably be able to give good results in practice. As to the calculation of the short-circuit current of an alternator, he considered this cannot be accepted as a test of any theory, the real test being to calculate the regulation on inductive loads. He thought, however, that the authors are doing good service in again emphasizing the advisability of guaranteeing regulation upon zero power factor rather than on non-inductive load. The most important point in the theory is the way in which account is taken of increased leakage caused by the back ampere-turns on the armature, the paper presenting for the first time any method of calculating the effect.

Prof. Adams took exception to the last statement, saying that the method used by Messrs. Hobart and Punga was described in detail by himself two years ago in almost exactly the same form. Mr. Behrend called attention to the fact that Prof. Blondel, some four years ago, published a theory based on tests made by Mr. Behrend on alternators, which was essentially the same as that just referred to. Mr. Gano S. Dunn pointed out that some of the criticisms were due to the evident misreading of the paper of Messrs. Hobart and Punga, and agreed with Mr. Behrend that engineering and designing of the kind to which the papers of the evening referred are not a science but an art. A consideration of innumerable factors is required, many of which are human rather than mathematical. Mr. Dunn mentioned the desirability of a construction whereby the bursting strain would be taken by the armature or revolving ring as an annulus and not by the spokes. Mr. Rushmore, referring to the remarks made concerning the difficulty of predetermined alternator regulation, said that when we get down to actual figures the regulation of alternators can now be estimated as closely as is desired. Referring to the matter of the strains and revolving armature, Dr. Perrine cited the case of a revolving field which is constructed with a smooth uniform rim bolted to spokes that had extended ends and with a spider construction that was not continuous. The rims are fastened to a spoke that is capable of extension and the former are so arranged as to produce the elastic spoke referred to by Mr. Dunn.

British Telegraphs and Telephones.

The Postmaster-General recently asked Parliament for $15,000,000 for the extension of the government's telephone system. The Postmaster-General also admitted in debate that the government was negotiating with the National Telephone Company for the purchase of their business.

The charge for telephones in London is £5 per year, plus 1d. per call for inner London, and 2d. per call for outer London, or an average of about £8 per year. The London system netted last year only £6,155, allowing nothing for an interest and depreciation charge of £60,780.

The government's telephone and telegraph systems in Great Britain last year cost £267,000 more than it earned, allowing for £167,000 received from the National Company as a bonus for doing business. The government has about £30,000,000 invested in telephones and telegraphs, the annual interest upon which is about £1,200,000. In other words, government control in this case costs some $6,000,000 per year.

A correspondent of the London *Times* says: "If we had a telephone service in London such as they have in New York or in any of the other cities of America, I venture to say there would, without question, be an enormous saving of time, temper and money; but so long as people are willing to tolerate the execrable service with which we in London are at present afflicted, so long will the authorities take no steps to improve the service."

Spring Meeting of the Magnetic Club.

The spring meeting of the Magnetic Club was held at Hotel Spalding, New York, on the evening of April 21, and in point of attendance and the prominence of the guests it was probably the record meeting of the club. The affair was planned on a liberal scale and successfully carried out, everyone present evincing that spirit of good fellowship for which the club is justly famous.

The Magnetic Club is essentially an organization of New York telegraphers, but a happy thought occurred to President Francis W. Jones in laying his plans for this meeting, and that was to get the telephone men interested in the club so that those connected with the two great organizations might meet together occasionally on a social plane and become better acquainted with one another. The result was that the meeting had a distinctively telephonic character, and the hospitality of the club was generously bestowed upon the many telephone officials present. The officials of the two great telegraph companies were also present to do honor to the telephone guests.

The guests of honor included Messrs. F. P. Fish, president of the American Telephone & Telegraph Company; E. J. Hall, vice-president, and Thomas D. Lockwood, c'ectrician; W. D. Sargent, J. C. Reilly and B. Gherardi, Jr., vice-president, general manager and electrical engineer, respectively, of the New York & New Jersey Telephone Company; U. N. Bethell, vice-president of the New York Telephone Company, and C. H. Wilson, general superintendent of the same company. Other well-known gentlemen present were Col. R. C. Clowry, president and general manager of the Western Union Telegraph Company, and J. C. Barclay, assistant general manager; Clarence W. Mackay, president of the Postal Telegraph and Commercial Cable Companies, and G. G. Ward, vice-president and general manager Commercial Cable Company; Col. A. B. Chandler, W. H. Baker and C. P. Bruch, of the Postal Telegraph Company; Melville E. Stone, general manager of the Associated Press, and H. L. Shippy, treasurer of the John A. Roebling's Sons' Company. Many other persons well known in the telegraph and telephone fields were present, there being about 250 in all.

After the dinner President Jones, in a few well-chosen remarks, introduced President Fish, of the Bell Telephone Company, who responded to the toast, "The Telephone." Mr. Fish evidently kept it in mind that the gathering was more in the nature of a social function than one assembled to listen to and discuss statistics and business problems, so he refrained from touching upon such matters. His remarks were confined to pleasantries regarding the telephone and the telegraph, and his sallies kept the company in good humor.

Mr. U. N. Bethell was next called upon to respond to the toast, "Professor A. G. Bell." The speaker paid an eloquent tribute to the character and work of the great inventor. He referred to Prof. Bell's steadfast faith in the future of the telephone, while capitalists, in the early days, looked upon it as a mere scientific toy. These capitalists, for whom Prof. Bell was developing some other inventions, actually placed a guard over the inventor to prevent him from wasting time on the telephone. By patient persistence, however, Prof. Bell demonstrated that he was right.

Persistent workers, said the speaker, are of more worth to the world than brilliant minds, and, combined, their efforts are irresistible. Mr. Bethell then reviewed the development of the telephone from its conception in the mind of Prof. Bell, in 1874, through the trying period of its growth up to the time when it became a practical every-day thing. He read extracts from a letter written by Prof. Bell in 1878 to show that at the very outset the inventor had a clear conception of the possibilities of the invention. The letter outlined a proposed method of running individual lines to a central point for interconnection, thus laying the foundation for what is now known as the telephone exchange. He even suggested the advisability of laying the wires underground and running them in cables.

"The telephone art," the speaker continued, "is changing so rapidly that no one dare take an extended vacation for fear that when he came back he would not understand things." Mr. Bethell treated his subject in a masterly manner and his address was listened to with the keenest attention and interest.

Other toasts responded to were: "The Telegraph," by Mr. C. P. Bruch, who was the first president of the Magnetic Club; "Old-Time Telegraphers," by Col. A. B. Chandler; "Cables," by George G. Ward; "The Press," by Melville E. Stone, and "The Magnetic Club," by John R. Van Wormer.

President Jones read a letter from Prof. Bell, in which the writer expressed regrets at his inability to be present at the meeting, owing to a prior engagement, which he had hoped to postpone, but found, at the last moment, that he could not break.

The speaking was interspersed by excellent vocal and instrumental music, an exhibition of ventriloquism being an interesting feature of the programme. Over the doorway of the banquet hall were placed two electric signs, one bearing the word "Hello" and the other the well-known telegraph signal, "O. K." These were used effectively during the addresses in flashing out their expressions by way of appreciation and approval at striking points in the remarks of the different speakers.

The menus contained a very fine three-quarter figure etching of Prof. Bell, made from one of his most recent photographs. It was an artistic piece of work and was carefully preserved by all as a souvenir of the occasion.

Electric High Pressure Fire Service in New York.

Mr. N. Hill, chief engineer of the Bureau of Water Supply, New York City, has made a report on the use of high-pressure fire service for the Borough of Manhattan, and Mr. I. M. de Varona has reported as to Brooklyn. The reports have been approved by the Board of Estimate and Apportionment, and call for an appropriation of $5,425,400, which the Board of Aldermen have voted for the purpose. The idea is to provide both fresh and salt water for fire and street flushing purposes. As between the three powers —steam, gas and electricity—the last is decidedly favored. Three pumping stations are proposed in the area of one-tenth of Manhattan, comprising the dry goods section and the East Side lower tenement district. Mr. Hill presents the following data as to electric plants compared with gas:

The mechanical efficiency of the gas and electric plants is approximately the same. In comparing the use of gas and electricity as the probable source of energy it may be well to present the following points in favor of electricity: 1. Economy in first cost of machinery and buildings. 2. Economy in space necessary for installation, thereby reducing cost of land required. 3. Economy in cost of wages, maintenance, repairs and renewals. 4. Simplicity.

The relative cost of power cannot be stated with accuracy until the price for which gas can be had is determined. Following is a statement of the comparative cost of one pumping station operated either by gas or electricity, an estimate of the probable operating expenses and fixed charges per annum, a similar summary for the three stations and an estimate of the total cost of high-pressure fire service complete:

COST OF ONE PUMPING STATION.

	Electric.	Gas.
Number of units in station	4	6
Capacity in million gallons per hour	1	1
Estimated number of hours plant will be in operation per year	80	80
Cost of motors and turbines, including piping, foundations, switchboard and wiring and cables	$255,000	.....
Cost of gas engines and pumps, including piping, foundations and auxiliaries, complete	.....	$448,000
Cost of buildings, foundations and land	90,000	270,000
Total cost	$345,000	$718,000
Cost of wages per annum	7,650	18,150
Cost of gas per year	.....	17,000
Cost of electricity per year at 4½ cents per kw-hour	13,200	.....
Cost of oil, waste and supplies per year	300	300
Cost of repairs per year	2,400	3,600
Total cost of operation	$23,550	$39,050
Interest and depreciation	26,710	55,000
Refunding sinking fund	11,500	27,000
Total cost per annum	$61,760	$121,050

Cost of Three Pumping Stations.

	Electricity.	Gas.
Cost of three stations	$1,035,000	$2,154,000
Operating expenses and fixed charges per annum for three stations	185,280	363,150

Summary of Total Cost.

Pumping stations	$1,035,000	$2,154,000
Mains for distribution system, complete, with gate valves and hydrants	2,107,000	2,107,000
Telephone system	150,000	150,000
Total cost	$3,292,000	$4,411,000
Add 10 per cent. contingencies	329,200	441,100
Add 10 per cent. superintendence	329,200	441,100
Totals	$3,950,400	$5,293,200

The pressure at the station is proposed to be 300 pounds and the minimum pressure at the hydrant 200 pounds. Mr. Hill counts apparently on drawing current supply from the mains of the Manhattan central stations and says that the three pumping plants would require 15,000 hp working at their full capacity. The data for Brooklyn follow the same general lines.

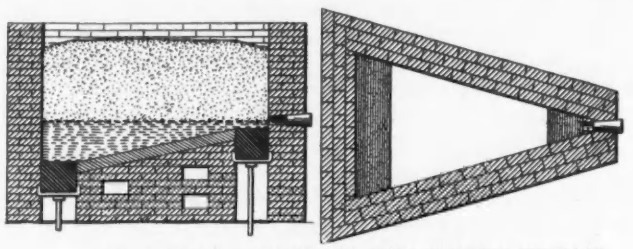
Recent Electrochemical Developments.

CALCIUM CARBIDE FURNACE.

Formerly the object of electric furnaces was to produce as high a temperature as possible; now the tendency is manifest to design furnaces in such a way as to always have the temperature under exact control. In some cases (in those in which the charge may give different products at different temperatures) it is evidently important to provide as uniform as possible a temperature throughout the furnace. Some of Mr. Acheson's recent furnace designs belong to this class.

In the manufacture of calcium carbide, the problem is a different and simpler one, and the main object of a large number of furnace constructions disclosed in seven patents granted on April 19th to Messrs. W. S. Horry and E. F. Price, of the Union Carbide Company, of Niagara Falls, is to design a furnace with a non-uniform distribution of the generated heat. While in general the temperature in the furnace must be sufficient for the formation of carbide, yet it is only near the tapping hole, where an extremely high temperature should be produced, sufficient to render the calcium carbide fluid at that particular place.

Several principles are made use of for this purpose. In several designs, the cross-section of the charge is diminished gradually towards the tapping hole, so that the current density is highest at that point. This is shown in Figs. 1 and 2, which represent a vertical and horizontal cross-section, the tapping hole being at the right.



FIGS. 1 AND 2.—HORRY AND PRICE ELECTRIC FURNACE.

In other designs a superposition of currents is made use of, for instance in the following manner: In a stack furnace a single negative electrode is provided at the bottom, and here is also the tapping hole. Several positive electrodes are provided at different heights of the furnace. If, through each of them direct current is sent into the furnace, which leaves it through the negative electrode at the bottom, it is clearly seen that the current passing through the charge becomes gradually greater as the bottom is approached.

Two of the patents refer to the use of polyphase currents for a furnace of circular cross-section. It is proposed to use a great many phases and to distribute electrodes at equal intervals around the circumference, each electrode corresponding to one phase. If a central electrode is provided which is connected to the neutral point of the polyphase system, then the temperature becomes highest near the center of the furnace, and the tapping hole is, therefore, provided at that place.

COPPER EXTRACTION BY ELECTROLYSIS.

A patent granted on April 19th to Mr. S. Laszynski, of Kielce, Russia, refers to the use of a tight envelope of fabric around an insoluble anode for the purpose of preventing anodic oxidation of the cations. For instance, in a solution containing ferrous sulphate the anodic reaction at the anode would be the oxidation of ferrous salt to ferric salt. In an electrolytic process of extraction of copper ores containing iron, this reaction would have the disadvantage that the ferric sulphate, while formed at the anode, might come in contact with the cathode and redissolve the deposited copper by local action. If a porous fabric envelope around the anode is used, the anodic reaction is essentially the formation of sulphuric acid and no ferric salt is formed since the ferrous sulphate does not come into contact with the anode. This envelope, therefore, acts like a diaphragm. The author states that in this way the direct electrolysis of copper baths containing iron is possible with a nearly theoretical efficiency, even if they contain twice as much iron as copper, since the iron remains in the state of the wholly unoffensive proto-sulphate of iron and with no corroding action of any kind.

MISCELLANEOUS.

A patent granted to Messrs. W. J. Joly and J. H. Joly, of San Francisco, Cal., refers to details of mechanical construction of apparatus for the electrolytic extraction of metals from slimes, sands and solution. The apparatus comprises essentially a sluice box and electrodes swinging on horizontal axes and adapted to float on the surface of a stream passing through the box.

A patent was granted to Mr. J. Bijur, relating to the manufacture of open-work structures for storage battery plates. The primary object is to enable strong and efficient plates to be made by embracing a number of individual elements having interstices—as, for instance, grilles or pastilles—with molten metal, to form the completed structure, although the elements may have any desired form. The interstices of the individual elements are first filled with a soluble material, like soda-ash, to prevent them from becoming filled with molten metal. The elements are then assembled in the desired arrangement with channels or spaces between them, and the channels filled with molten metal to embrace the elements to form the completed structure. The soda-ash is then removed to leave the finished open-work plate.

A patent granted to Mr. A. V. Meserole, of New York City, refers to the construction of a light and durable storage battery plate in which the mechanical strain is distributed by a new arrangement of the electrodes and their supporting devices. A supporting bar is provided with depending tubular members through which bolts are threaded. A stirrup plate is mounted on the bolts and tablets of active material encircle the tubular members and rest upon the stirrup plate.

A patent granted to Mr. J. H. Reid, of Newark, N. J., relates to his "gas battery," which has been noticed before in these columns. The object of the present patent is to obtain a circulation of the electrolyte so that "the bubbles in the electrolyte formed by the action of the gas or gases in the development of the electric current may be broken up and the inert gases allowed to escape."

New Telephone Patents.

A WELL-DESIGNED DESK STAND.

While the tendency on all sides has always been toward the simplification of the telephone subscriber's set, it is apparently but recently that any great effort has been made to make the internal workings readily accessible. In receivers this effort has resulted in some designs which when considered from this standpoint approach

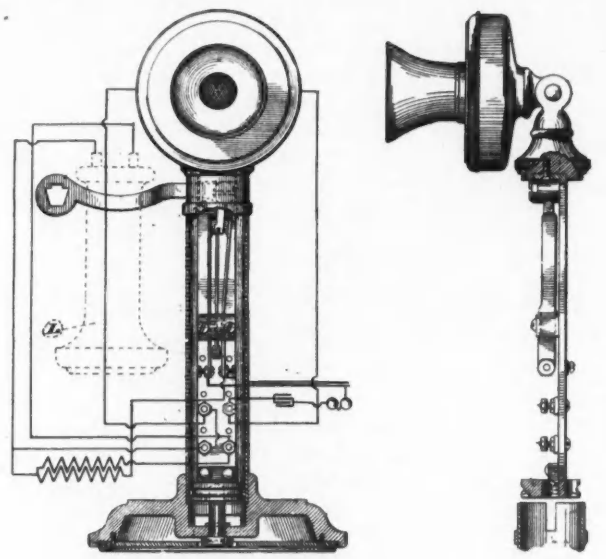


FIG. 1.—CLAUSEN DESK TELEPHONE.

perfection, and now that similar good work is being done on the desk stand set is evidenced by a patent just issued to Mr. H. P. Claussen, of Chicago. In this stand the removal of a single screw from the base plate allows of the whole stand being knocked down. The base comes off and then the tubular upright may be slipped down over the cord, entirely exposing the working parts. These latter are all mounted upon a strip of insulating fibre which is secured to the transmitter bracket piece. A good idea of the arrangement of the parts may be obtained from Fig. 1, which shows a partial sectional view, and a side view of the transmitter with those parts integrally connected thereto. Mr. Claussen has assigned his patent to the American Electric Telephone Company.

POCKET MICROBE CATCHER.

Of all the numerous antiseptic devices for telephone transmitters thus far brought out, that which has recently been patented by H. S. Thompson, of Waterbury, Conn., seems to have most points in its favor. This is a device put up to be carried in the pocket and differing little in size and shape from a watch. The case is of a diameter to just fit over the transmitter mouthpiece, a screen of gauze being stretched across it. Each cover carries a pad which contacts with the gauze whenever the case is closed. These pads are wet with

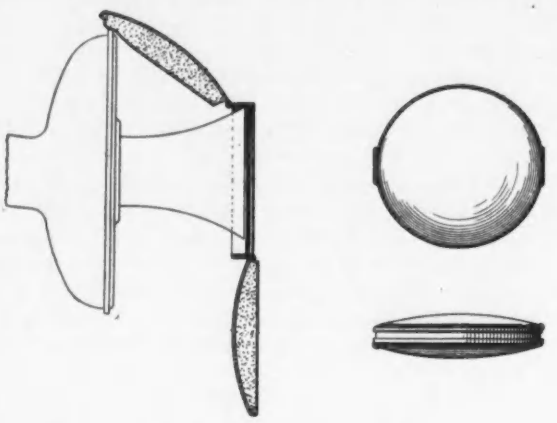


FIG. 2.—THOMPSON ANTISEPTIC ATTACHMENT.

antiseptic solution. Fig. 2 shows the case closed and in position for use.

TRANSMITTER.

W. L. Wilhelm, of Buffalo, has had issued a patent for a special type of casing for a double-diaphragm transmitter. The casing is of ellipsoidal shape, the mouthpiece surmounting one of the smaller ends. The diaphragms are in a plane parallel to the long axis and the sound waves are conducted to them through two curved tubes, which combine into a threaded ring as they approach the mouthpiece. This ring screws into the casing.

SELECTIVE SYSTEMS.

Two selective systems for party line signalling complete the list of patents. Both these are step-by-step systems, the one most simple and the other of a complexity apparently fatal to its success. The former is the work of Albert Meinema, of Chicago, while P. H. Fisk, of Clay, Iowa, is the inventor of the latter.

In Mr. Meinema's system a rotating ratchet wheel is interposed between the hook switch lever and its springs. When the wheel is in the proper position the bell of that station is connected to the line. The further actuation of the hook switch springs into the talking connection also depends on the position of this same wheel, and thus a lock-out for non-wanted stations is provided.

National Electric Light Association.

Mr. Charles H. Hodskinson, chairman of the committee on hotel accommodations for the twenty-seventh convention of this association, to be held in Boston May 24, 25, 26 and 27, reports that an unusually large number of rooms have already been assigned to members. The placing of this matter in the hands of a committee to whom all applications for rooms are referred, will undoubtedly result in better satisfaction for members of the association, as they will be cared for first and will not be obliged, should they be a little late in deciding to attend, to make the best of such accommodations as were left after non-members have been provided for, as has often happened in former years.

In addition to the New England Passenger Association and the Trunk Line Association, the secretary reports that the Central Passenger Association and the Southeastern Passenger Association have made a rate of a fare and a third for the round trip, from all points throughout their territory for delegates and friends attending the twenty-seventh convention at Boston. Mr. Frank L. Perry, of the *Western Electrician*, has consented to take charge of transportation matters for Chicago and vicinity, and proposes to arrange for a special train to bring delegates to the convention. Mr. Perry's well-known energy ought to insure the success of this effort.

The following are among the recent additions to the membership of the National Electric Light Association: Active—Connecticut, South Manchester, South Manchester Light, Power & Tramway Company. Indiana, Marion Light & Heating Company. Massachusetts, Leicester, Rawson Light & Power Company. Mexico, Monterey, Monterey Light & Power Company. New York, Little Falls, Herkimer County Light & Power Company; Lockport, Lockport Gas & Electric Light Company. Washington, Olympia, Olympia Light & Power Company. West Virginia, Bluefields, East River Electric Company. Associate—Indiana, Jonesboro, India Rubber & Insulated Wire Company. Iowa, Keokuk, Garton-Daniels Company. Missouri, St. Louis, Wagner Electric Manufacturing Company; St. Louis, The Emerson Electric Manufacturing Company. New York City, Sanderson & Porter, 52 William Street; Holophane Glass Company, 15 East Thirty-second Street; The Electric Carriage Call Company, Incorporated, 328 West Forty-first Street; New Brighton, C. W. Hunt Company.

The Cumberland Telephone Company in Evansville, Ind.

The Cumberland Telephone Company, of Evansville, Ind., has made the city council a proposition with a view to settling the controversy between the city and company and end further litigation.

The terms proposed by the Cumberland Company are: First, to submit the question of telephone rates to a committee of arbitration. The Cumberland agreed to Major Gilchrist, one of the attorneys for the so-called municipal telephone; Col. R. K. Dunkerson, a director of the municipal company, and A. C. Rosencranz as the committee. In case this committee was not satisfactory to the council it is proposed that the city make one nomination, the company another and the two to select a third. This committee may hire an expert accountant, who can examine the books of the Cumberland Company, both in Evansville and Nashville. The only stipulation is that the committee be of such a character as to command the confidence of the people of the city.

Second, growing out of the first proposition, the committee is to determine whether the city should be given a bonus by the company or pay an annual stipend. The entire matter of rates and compensation is to be left to the arbitration committee.

Third, the agreement shall be entered upon the journal of the United States District Court of Indiana and have the effect of decree of court. In effect it would be a permanent injunction against the city from removing the poles and wires of the Cumberland Company.

Subsidiary considerations discussed at the meeting between the Mayor and representatives of the company were:

First, a suggestion that the Cumberland Company pay the cost of the city in defending the injunction suit brought by the Cumberland against the city; that the Cumberland pay the attorney fees and cost of preparing the case, though the amount was not discussed. The cost of defending the Richardson suit was not mentioned.

Second, while it was not requested by the Mayor or offered by the company, there was an informal suggestion that the Cumberland assume the losses of the defunct Municipal Telephone Company. It is understood this amounts to nearly $7,000.

Briefly stated, the Cumberland offers to leave to arbitration of a committee of Evansville business men the rates to be charged and the compensation to be given the city. Their finding is to be made a record of court and in return the Cumberland is to have practically a perpetual franchise. The company also offers, aside from any award ofthe arbitration committee to pay the cost of the recent suit and perhaps to recompense the losses of the municipal telephone fiasco. No exclusive franchise is or could be asked for. Other companies may be admitted to the field. Action upon the proposition of the Cumberland Company rests with the Mayor and council.

Volunteer Russian Telegraphers.

The Czar of Russia has accepted the offer of the senior class of the Electro-Technical School at Odessa to serve as volunteer telegraphers in Manchuria. These volunteers will have charge of the wires along the Manchurian line.

Prices of Radium in France.

It is stated that the makers of Curie's radium can furnish it in several different degrees of purity, and therefore in varying intensities. A price list is given for radium and barium chloride, except the lowest activity, which is a compound of radium and carbonate. The minimum quantities sold as well as the current prices for radium are stated. The prices vary from $1.50 per gram for 40 activity to $1,250 per gram for 20,000 activity. The prices, it is stated, are advancing from week to week, owing to the enormous demand.

CURRENT NEWS AND NOTES.

SEOUL ELECTRIC PLANT BURNED.—Fire destroyed the imperial palace at Seoul, Corea, April 15. The new electric lighting plant was also destroyed.

VERMONT ELECTRICAL ASSOCIATION.—This association will hold its next meeting in Montpelier, September 21 and 22 next. Mr. C. C. Wells, Middlebury, Vt., is secretary.

WIRELESS IN SOUTHWEST AFRICA.—Germany, which is having serious trouble with the natives there, is sending men to German Southwest Africa equipped with wireless telegraphy apparatus and balloons to be used in the campaign against the Herreros.

CANADIAN ELECTRICAL ASSOCIATION.—The next annual meeting of the Canadian Electrical Association will be held in Hamilton, Ont., June 15, 16 and 17 next. A series of interesting papers has been arranged for. Mr. C. H. Mortimer, Toronto, Ont., is secretary.

STATE ELECTRICAL ENGINEERS.—The New York State Civil Service Commission among examinations to be held May 21, 1904, will include positions for electrical engineers in State hospitals and institutions. Application must be made to the chief examiner, C. S. Fowler, Albany, before May 16.

ELECTRIC AUTOMOBILES.—A cable dispatch from Paris of April 23 says: "Electric automobiles bid fair to eclipse petroleum vehicles for town locomotion. Manufacturers are selling them as rapidly as they can produce them. At the Société Française des Electromobiles it is almost impossible to hire a machine." France usually leads the way in these things.

BUFFALO TO CLEVELAND.—The De Forest wireless system is now in successful commercial operation between Buffalo and Cleveland, an air distance of 170 miles, most of which is overland and part across Lake Erie. The poles are 195 ft. high, with 11 wires for sending and 3 for receiving. Dr. Lee De Forest has had personal charge of the equipment.

WAR PENSIONERS.—An article on "Our Enormous Pension Roll," by Mr. R. L. O'Brien, in the *World's Work* for May, contains some very interesting and curious data. It tells of one man who drew a pension for total deafness, on the certificate of an examining committee, and was found in active charge of a telephone switchboard. The State of Georgia at one time had so poor an opinion of lightning rods that it did not grant its Confederate veterans the usual exemption from license in connection with their sale.

REUNION OF POSTAL TELEGRAPH OFFICIALS.—A reunion of officials and heads of departments of the Postal Telegraph-Cable Company from all over the country will be held in New York May 24 next. The gathering is for the purpose of exchange of ideas and experiences for the general good of the service. This meeting will also celebrate the sixty-fourth anniversary of the invention of the telegraph. It is proposed to hold these meetings annually hereafter. The last general convention of officials was held ten years ago.

ELECTRICITY IN PARAGUAY, S. A.—Mr. J. N. Ruffin, United States Consul at Asuncion, Paraguay, says: "An electric lighting plant has been established here, though the lamps have not yet been put up. If the enterprise is successful it will be extended so as to supply electric motor power, the introduction of fans, etc. It seems as if the electric light will be a success, and in view of this some persons have applied at this consulate for catalogues of electric lamps, fans, etc., accompanied with export prices, if possible written in Spanish."

PAIN-KILLING RADIUM.—Doctor Darier, of Paris, describes a case of cancer of the face which, through application of radium, had been rendered painless. Similar results have been obtained by other noted experts. He has also found quick and pain-killing effects of radium in certain diseases of the eye. The influence of radium upon the motor-nerve centers he considers of still greater importance. In two cases of nervous spasms—which occurred three to four times a week—weak radium preparations were applied to the temples for two or three days, when the spasms ceased. In a case also of presumptive inability of motion, caused by nervous debility, radium effected a complete cure within three days—probably, however, through suggestion. In acute facial paralysis of entirely new origin, radium effected a cure in one day.

WAR RULES FOR WIRELESS.—A cable dispatch to the New York *Times* of April 21 says: "The British Government is giving careful consideration to the Russian edict in reference to the use of wireless telegraphy by war correspondents in the Far East. Whether it has made any representations to Russia in the nature of a protest against her line of action, it is impossible to state at this moment; but if such representations have not yet been made, it is quite likely that they will be made. At any rate, Lord Lansdowne is fully impressed with the view that the attitude Russia has assumed as to wireless telegraphy is unjustifiable and altogether absurd. The only correspondent directly affected by the Russian note is the correspondent of the London *Times* and the New York *Times*. Lord Lansdowne, who fully understands the methods and status of this correspondent, unqualifiedly repudiates the Russian contention that he is in the same category as a spy, and condemns the purposes Russia entertains in respect to the correspondent, his chartered vessel, and his wireless telegraphy apparatus."

ELECTRICITY IN JAVA.—Mr. B. S. Rairden, United States Consul at Batavia, Java, informs us that the only city in Java with electric lighting is Batavia. The harbor of that city, Tandjong Priok, also has its own lighting station, owned and operated by the government. There are three telephone exchanges in Batavia and a system for long-distance work connecting the city with Samarang and Soerabaya (Intercommunale Telefoon Maatschappij). There is also another telephone exchange—Batavia-Soekaboemi Telephone Company—which connects Batavia with Buitenzoig and Soekaboemi. The telephone systems have a number of American instruments in use, and are using more American material lately, the appliances and material being found superior by the Netherlands-India Telephone Company. The eight miles of trolley in Batavia were equipped by Siemens & Halske, of Berlin, who also put in the electric power plant, which operates the government opium factory. The street railway company is known as the Electric Tram Company, or Electrische Tram Maatschappij. There are two electrical supply houses —Maintz & Co. and Carl Schlieper.

A NEW COLOR QUESTION.—According to veracious advices from Philadelphia, "Dr. Thomas R. Eldridge, of 1639 North Broad Street, for several months has been making a series of experiments, the aim of which has been the transforming of negroes into whites. There was a fire at the surgeon's establishment last Sunday and the apparatus with which the experiments were being carried on were destroyed. As a consequence there are half a dozen negroes who are guessing hard. Dr. Eldridge was doing the bleaching by throwing an X-ray light through radium, thus destroying the coloring pigment of the skin. Several negroes who had undergone treatment are now partly white. With the destruction of the electrical appliances the work of completing the transformation is halted. The patients are, therefore, left in a state of what might be termed dermatological suspense. It will be several months before duplicate apparatus can be built. Meantime, Dr. Eldridge does not know what will become of the blacks. He does not think that the whitened parts of the skin will become black. All he knows just now is that there are a half dozen unhappy negroes in Philadelphia."

EXTRACTING NAIL FROM BODY.—According to a statement from Salt Lake City, a nail has been drawn from a point close to the heart of Louis E. Cherry, aged 16 months, by an electric magnet. The child swallowed a nail two weeks ago. Experiments on a dog showed it to be impossible to extract a nail with the usual instruments. A long curved piece of steel, attached to a powerful electro-magnet, was pushed down the windpipe, and as soon as the current was turned on the nail became attached to the steel and was withdrawn.

WIRELESS IN WAR.—At a meeting of President Roosevelt's Cabinet last week a discussion was had, it is credibly reported, looking to the control by the government of wireless telegraphy. The opinion was expressed that it would be desirable, if not, indeed, absolutely necessary, for this government to control, at least in a supervisory way, the operation of wireless telegraphy, particularly along the coast. It was pointed out that, in the event of a war with a foreign nation it might be necessary in defence of the nation for officers of the United States to have charge of these stations, as a means of assurance to the government that no communication was established with vessels of the enemy's fleet, and that the system was not employed to the detriment of United States interests.

SIBLEY JOURNAL OF MECHANICAL ENGINEERING.—The contents of the current issue of the *Sibley Journal of Mechanical Engineering* belie its title, two of the three papers contained treating of electrical subjects. Prof. H. J. Ryan contributes an interesting paper entitled "Some Problems in Electrical Engineering Due to Conductivity of the Atmosphere," in which, after pointing out the gravity of the problem of atmospheric conductivity in connection with high-voltage transmission work, he gives the results of experiments to determine the variation of such conductivity in the case of conductors in an undue pressure. It is shown that air under a compression of 150 pounds per square inch has an insulating strength at least ten times its normal strength. The second paper referred to is by Mr. Bion J. Arnold, and describes the Arnold electro-pneumatic railway system in detail.

ELECTRIC ROAD UP VESUVIUS.—Visitors to Naples familiar with the old Funicular Railway that for twenty-three years has been in operation on Mount Vesuvius will welcome the news that the long and dusty drive from Naples to the old station has at last been obviated by the opening of a new electric railway. The starting point of the new line, which has been constructed for Thomas Cook & Son, the tourist agents, is at Pugliano, where connection with Naples by electric cars is made. The length of the railway, exclusive of the old line up the cone, is 4.7 miles, and it is divided into three sections. The first and third sections are ordinary lines; the second section is a rack railway, with an incline as great as that of the famous Rigi Railway, in Switzerland. The cars of this section are pushed up by a powerful four-wheeled electric locomotive, fitted with an elaborate system of ordinary and emergency brakes. The current throughout is picked up by overhead trolleys. At the Hermitage Cook's have built a hotel, near the famous Royal Observatory. The new line makes the trip from Naples to Vesuvius a much more speedy and comfortable journey than it has hitherto been.

AUSTRIAN TRANSMISSION SCHEME.—Mr. S. C. McFarland, United States Consul at Reichenberg, Austria, says: "A project for the establishment of a central distributing electric power and light plant in the Reichenberg land district has taken definite form. The territory included is about 10 miles square, and 24 towns and villages have joined in the movement and subscribed to the capital stock. Some 10 more are expected to join. The population of the district, exclusive of Reichenberg, is about 60,000. Stock is subscribed at present to the amount of $200,000, and this it is proposed to increase to $400,000. The principal purpose of the corporation will be the distribution of electric light and power, with the possibility of installing and operating a system of suburban electric tramways. Tramway and light franchises for the city of Reichenberg are at present owned by private corporations, and at their expiration it has been generally supposed that the city would take over and conduct the enterprises. Negotiations are pending, however, which may change the situation in this respect. Communications regarding equipment, etc., may be addressed to Directors Alfred Ginskey, Maffersdorf and Dr. Richard Pirkl, Reichenberg."

LETTERS TO THE EDITORS.

Maximum Efficiencies of Transformers and Constant Potential Shunt Motors.

To the Editors of Electrical World and Engineer:

SIRS:—Dr. Kennelly's article on "The Efficiency Curves of Constant-Potential Transformers," in your issue of April 16, I have read with much interest. Dr. Kennelly has given to an old proposition a new and elegant graphical solution. He has also drawn attention to the fact, which I do not remember to have seen mentioned before, that the efficiency curve of a constant-potential transformer is an acute hyperbola.

Permit me, however, to call attention to the fact that the chief conclusion of Dr. Kennelly's paper was published in two articles of mine in the ELECTRICAL WORLD AND ENGINEER for September 18 and November 6, 1897. In these papers will be found the analytical proof that at maximum efficiency the copper and iron losses of a transformer are equal to each other. This is the main point in Dr. Kennelly's summary.

Further, for the past three years I have given to my class in electrical design a similar demonstration to show that in a constant-potential shunt motor, at maximum efficiency, the approximately fixed losses are equal to the variable copper loss in the armature. This conclusion is not so exact for the shunt motor as for the stationary transformer, but I have applied it in tests made on a number of motors and have found it to hold near enough for many practical purposes.

The demonstration is as follows: Let b be the fixed losses in watts in the motor, including iron loss, field current, windage, etc. The armature copper loss is I^2R, in which R is the resistance of the armature. Then at any load the losses are $I^2R + b$, while the input is IE, where E is the constant-potential difference at the terminals of the motor. Then for maximum efficiency the fraction $\frac{I^2R + b}{IE} = c$ should be a *minimum*. Differentiating, $\frac{dc}{dI} = \frac{R}{E} - \frac{b}{EI^2} = 0$ for a minimum. Whence we have

$I^2R - b = 0$, or $I^2R = b$. Hence, at a load giving maximum efficiency, the copper loss in the armature is equal to the fixed losses, or the stray power losses plus the loss in the shunt field.

UNIVERSITY OF MICHIGAN. HENRY S. CARHART.

Steam Turbine Economy.

To the Editors of Electrical World and Engineer:

SIRS:—The writer was interested in the letter in your issue of March 5 from Mr. Cyrus Robinson regarding the steam consumption of an air pump used in testing a 1,250-kw turbine unit. On several different occasions I have put a steam indicator on our air pump (which has an 8-in. steam cylinder, and two 20-in. air cylinders, with the vacuum being from 28 to 29 in.), and found the steam consumption to be 9 indicated hp. We are aided a good deal by running the exhaust steam from the air pump and some of the other auxiliary machinery into the condenser, so that the engines are run condensing. This statement may be of some interest to those who are anxiously inquiring about turbine efficiency.

PORT HURON, MICH. J. E. DAVIDSON.

Silicon and Silica.

To the Editors of Electrical World and Engineer:

SIRS:—On page 733 in your issue of April 16, in a report of the Washington meeting of the American Electrochemical Society, I am quoted as suggesting the use of silicon as a possible substitute for glass as a container for standard cells. Some erratic genius inserted the remark that pure silicon is now made cheaply by a certain patentee.

My suggestion made no reference whatever to silicon, but to

silica, sometimes called "quartz glass." In view of the solubility of various forms of glass, and the great liability of glass varying in composition in different countries and at different times, it is advisable to investigate the effect of glass containing vessels for standard cells, and possibly to substitute therefor vessels of silica, which does not vary in composition and is much less soluble than any of the ordinary glasses.

New York City. Henry Noel Potter.

Reciprocating vs. Turbine Engines.

To the Editors of Electrical World and Engineer:

Sirs:—In the communication of Mr. Hodgkinson, criticising the writer's article in your issue of April 2, he first states that the data published in the article appeared to be reliable, and then proceeds to intimate that there are discrepancies in the results given as compared with those in the paper of Messrs. Moultrop and Curtiss, read before the A. S. M. E., which was referred to in the article. This paper specifically gave only the results of four single tests at full load made with and without the reheater for engine No. 8, and with and without the reheater for engine No. 9, respectively. The writer's article stated definitely that the average results given were made up from all the acceptance tests, which were made with reheaters in use, of engines No. 9, No. 10 and No. 11, and that the results of tests on engine No. 8 were not included for the reasons given. The least that can be said is that there are no grounds for the comparison made by Mr. Hodgkinson. Necessarily, from the above, only one of the tests mentioned in the paper by Messrs. Moultrop and Curtiss was used in making up the average results given in the article. The individual tests given in the latter were not mentioned in the paper, nor were the tests on engines No. 10 and No. 11, which in fact were made at a date subsequent to its reading.

It would doubtless have been somewhat more satisfactory, for purposes of comparison, if these engines had been tested at less than half load. On the other hand, it is not often possible to obtain such an accurate measure of the actual performance of an engine as is afforded by carefully conducted tests of several identical engines under substantially identical conditions. Furthermore, it is unfortunate that no reliable electrical instruments were available in the series of tests conducted by Prof. Hollis and Prof. Marks. At the same time the rates of B.T.U. per minute and the corresponding efficiency ratios given, respectively, on an indicated horse-power basis for full, quarter and half loads for these tests, and for the corresponding points on the curve *C*, form just as reliable and satisfactory a check upon the form of curve *C* for steam consumption at light loads as though direct electrical readings had been obtained.

Mr. Hodgkinson objects to the method of indicating the relation of total losses at different loads, shown in Fig. 2. In the original article by Mr. Mattice, the comparative percentage of the total losses at different loads was discussed. In laying out Fig. 2, the basis of comparison indicated by Mr. Mattice was followed. Moreover, the observations indicated include those obtained from a number of engines in other locations differing both in combined efficiency and in steam consumption, and this affords a comprehensive method of determining the law of variation of the total losses. In this connection a typographical error in the second sentence on page 652 should be noted. It should read: "The efficiency ratio given in the table, etc."

The objection of Mr. Hodgkinson that the article does not state whether allowance had been made for variation from contract conditions in determining the basis of full load rating in laying out curve *C*, is well taken. In laying out this curve it was considered proper to determine full load on the basis of rated cut-off, as indicated by Mr. Hodgkinson, which, under the actual conditions, gives a full-load rating of 2,040 electrical horse-power.

The point of Mr. Hodgkinson's comments on the necessity of expansion to back pressure for maximum economy with an ideal engine is not apparent. No one would attempt to run an actual reciprocating engine of the condensing type and expand to back pressure with the idea of securing good economy, or to maintain that there was any similarity between a reciprocating engine and the steam turbine in this respect. What the writer intended to show in this connection was that when the economy of any type of engine is improved by a reduction of the clearance due to the use of a longer stroke or better design, or by a reduction of cylinder condensation from the use of reheater or superheated steam, or in any way which improves the ratio of its thermal efficiency to that of the ideal engine, the resulting saving in steam consumption will be proportionately greater at light than at heavy loads, and the curve of water consumption for light loads will be flattened, as shown in curve *C*. This is equally true of any make of reciprocating engine which is so constructed that high economy is secured.

Mr. Hodgkinson asserts that the curves of steam consumption given show "an important feature of the turbine—that it may be run at full load with its best economy—whereas an engine must be run at about 25 per cent. underload to secure its best economy." This last clause seems like hair-splitting, since results indicated by curve *C* show a rate of steam consumption from half to full load, which is practically constant; that is, it varies less than 2 per cent. from the full-load economy. These engines also have an overload capacity of over 80 per cent. above rated load if the steam pressure and vacuum be maintained.

Mr. Hodgkinson's argument that this reciprocating engine with its practically constant rate of steam consumption from half to full load, and with its large overload capacity is over-rated, and that the general form of its curve of steam consumption for different loads is inferior as compared with the corresponding curves given for the turbine in question, appears like an attempt to befog the situation, in view of the fact that since the turbine curve falls away materially with any reduction of load below full load, on the one hand, it must be run at full load to secure economy; and on the other hand, it can carry no overload unless an attendant is on the spot to open a hand-operated by-pass arrangement for letting steam pass directly from the boiler around the high-pressure end of the turbine, with consequent increased drag upon both boiler and condenser. In fact, the by-pass arrangement hardly seems for overloads "one that is suitable for the most exacting demands of fluctuating loads."

According to his figures, if the vacuum should fall to, say, 21 in. instead of 25 in., which, however, does not seem unreasonable, the capacity of the turbine would be cut down 30 per cent., with a corresponding increase in steam consumption, and under such conditions with a drop in steam pressure of 10 per cent., the turbine would not pull its rated load, with by-pass full open.

Mr. Hodgkinson asks in several places in his letter for more tests —more data. This is an invitation to a controversy which the writer must decline, and it does not seem that this would interest your readers. The article was intended solely to correct a prevailing wrong impression that a reciprocating engine, even when of the highest economy at full load, must necessarily be wasteful of steam at light loads, an impression which turbine advocates have made use of a great deal in making comparisons. It was in no sense meant to cover the general subject of the comparative economy of turbine and reciprocating engines, in which case an allowance for the material difference in vacuum, etc., would have been proper. For such a comparison the present time seems inopportune to the writer. The results of tests by disinterested parties of steam turbines which have been in actual service for a sufficient number of years to judge properly of their lasting qualities are too poor to be worth comparing with an up-to-date reciprocating engine. Only a trying-out process will determine, not only how far the expectations of greatly increased economy will be realized from the many improvements in steam turbines which are being actively exploited at the present time, but, *more especially*, how these improvements will affect the durability and lasting qualities of the turbine. There would seem to be no difficulty in making a turbine which will give, after careful adjustment, good results for a short time, provided sufficiently close clearance or sufficiently high steam velocities are used. The question is how far can one go in this direction in a machine which will at the same time prove sufficiently robust for commercial handling, and will also prove to be durable and without deterioration in economy. It would seem that time is needed to solve this problem.

Auburn, N. Y. J. A. Seymour.

Variable-Speed Motors.

To the Editors of Electrical World and Engineer:

Sirs:—The writer has been using electric-driven machine tools for some time. He has used variable-speed motors, obtaining his speed changes by varying the field strength. He has, however, had

some trouble with the motor starters and field rheostats. So much has been written lately regarding systems of control for variable-speed motors that the writer thinks some attention should be paid to special types of controllers for use with variable-speed motors. From an operator's standpoint, I have the following complaints to make against apparatus which I have received from motor manufacturers who have sold me variable-speed motors with their controlling outfits for my machine tools:

1. Upon weakening the field to get higher speed, the underload release magnet has released the arm and stopped the motor.

2. Upon starting up under load my fuses have blown, the underload magnet not being operative during the starting period.

3. Upon starting the motor under weakened field conditions while under the lightest load, my fuses have blown.

4. I have had some trouble due to metallic chips falling upon the exposed resistance coils in the box, causing short-circuits, thus destroying the box.

I believe, therefore, that some better apparatus could be constructed and that some attention should be given this question as it is the only complaint which the writer has found against the driving of milling machines and such class of goods by use of variable-speed motors. I would thank any of your readers who wauld take this matter up and co-operate with me.

BRONXVILLE, N. Y. CHESTER BURKHARDT.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Converters.—LOEWY.—In a continuation of his serial on electric machine construction in 1903 he discusses converter designs by Davis, Lamme, General Electric Company, Auvert and the following machine of Bragstad and La Cour. The latter, shown in Fig. 1, consists of an induction motor coupled with a rotary converter, *U*, the secondary winding, *R*, of the induction motor being connected to the armature winding of the converter. *S* is the stator winding of the motor, *W* the starting resistance, *K* the commutator, and *F* the direct-current field of the converter, which is in shunt with the direct-current circuit. If motor and converter have the same number of poles, the two machines coupled together run with a speed which corresponds to half the frequency of the primary current. An e.m.f. of half the frequency of the primary current is thereby induced in the rotor winding of the induction motor. On account of the connection of the rotor winding with the armature winding of the converter, a rotary field is produced in the latter which revolves (with regard to the armature) with a speed equal to that of the armature. If the connections are so made that the rotary field revolves in the opposite direction as the armature, then the rotary field is stationary

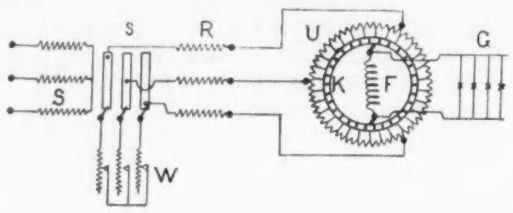


FIG. 1.—CONVERTERS.

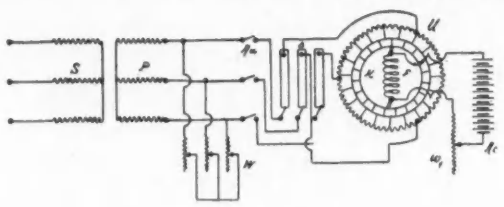


FIG. 2.—CONVERTERS.

in space and the machine acts at this speed like a synchronous motor. The induction motor acts to one half as motor and to the other half as transformer, while the converter acts to one half as direct-current generator and to the other half as converter. The relative position of both stationary converter fields depends upon the load of the machine, and the relative position of both fields can be changed only by an external force. In the case of an external disturbance there exists a strong synchronizing force, because there is only a relative displacement of the converter fields, but also one of the fields of the induction motor. For starting the converter, the resistance, *W*, is used which is gradually disconnected so that the speed gradually increases. With correct excitation, the condition of synchronism is reached by itself and the resistance may be short-circuited. The arrangement is shown of using the machine for converting single-phase into direct current and also for using it as an alternating-current motor. Fig. 2 shows the application of such a motor for three-phase traction. The stator winding, *S*, is placed between the rails on the road, while the rotor winding, *P*, is mounted on the car. The converter, *U*, is connected to the driving axle of the car. When starting, the switch, *Au*, is open, and the car is started partially by means of direct current from the battery, *Ac*, and by means of three-phase current. When the speed is reached at which the frequency of the three-phase current induced in the rotor is equal with that of the armature current of the converter, the switch, *Au*, is closed and the resistance, *W*, is opened so that the car continues to run at this speed, which corresponds to synchronism. When the resistance, *W*, is decreased the speed of the car increases and the converter, *W*, sends current into the battery, *Ac*. Fig. 3 shows the application of the machine as alternating-current generator with the non-synchronous machine, *G*, as main generator and the converter, *Er*, as exciter. The exciter and the generator are self-exciting if the field of the exciter has body poles. The alternating currents generated

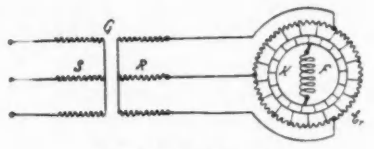


FIG. 3.—CONVERTERS.

in the exciter produce a rotary field in the rotor of the non-synchronous machine. The currents induced in the stator of the non-synchronous machine have a frequency which is equal to the sum or difference of the speed of the rotor and the speed of the rotary field in it. Such a generator is, therefore, suitable when connected with high-speed prime-movers, like steam turbines, for furnishing alternating current of a lower frequency than would correspond to the speed of the prime-mover.—*Zeit. f. Elek.* (Vienna), April 10.

Alternators Connected in Parallel.—SOMMERFIELD.—The first part of a long theoretical article. The author first sums up the former papers by Kapp, Benischke, Goerges and Rosenberg on this subject. The common feature of the various explanations given by these authors is the consideration that by the driving machine a forced oscillation is impressed on the machine set and that on the other hand, the system is capable of a free oscillation, the period of which depends upon the mechanical and electrical constants of the two machines. The special phenomena of surging make themselves manifest when both oscillations are in resonance. Benischke also emphasizes the possibility of interference between the free and forced oscillations. The influence of the regulator may be considered as a separate problem. The present author starts from the mechanical and electrical differential equations of the generation of current as the simplest foundations of the phenomena. He does not discuss the process of connecting in parallel, but speaks only of the conditions which are obtained when the connection in parallel is made in the proper way at equal instantaneous values of voltage and when the main power of both machines is equal. His mathematical equations lead him to a mechanical analogy with the pendulum and he has devised an apparatus which he calls the "sympathetic pendulum" for demonstrating the phenomena of surging. The article is to be concluded.—*Elek. Zeit.*, April 7.

Distorted Magnetic Fields.—GOLDSCHMIDT.—The first part of an article, illustrated by diagrams, on distorted alternating and rotating magnetic fields. It is pointed out that an induction motor shows great sensitiveness to distortion of the voltage curve, especially to the higher harmonics of the lower orders, such as the third, fifth and seventh harmonics. The following experiment is described. A no-load test on a 400-volt, 50-period, 1,000-revolution, 70-hp, three-phase motor was first carried out, using a small generator which had been designed for about 350 volts and 50 amp. This was over-excited to give 400 volts and the test showed a no-load current of 42 amp. The test was then repeated using a three-to-one ratio transformer to raise the voltage so that the generator should be working with a much higher current at a lower voltage, the percentage voltage drop being increased approximately nine volts. The transformer also had a considerable drop at the load employed. With the same voltage (400 volts) at the motor terminals, the no-load current now measured only 30 amp., against 42 amp. when supplied directly from the generator. The chief cause of the difference was curve distortion. In the first test this distortion had full play, while in the second the high reactance of the circuit prevented the occurrence of currents of high frequency.—Lond. *Elec. Rev.*, April 8.

LIGHTS AND LIGHTING.

Train Lighting.—An account of the results obtained with various systems of electric train lighting on the State Railways of Prussia. On the D-trains, between Berlin and Stassnitz, and between Berlin and Altona, the following system has been in use for over a year and has proven very satisfactory. The lamps in all cars are supplied with current from one steam dynamo consisting of a 20-hp Laval turbine geared to a shunt dynamo and placed on the locomotive. The cars are provided with batteries which supply the lighting current only when the locomotive is disconnected from the train. In case of an accident to the machine, the batteries are capable of furnishing current for all lamps for three hours. Since the machine and the battery are continually at the lighting circuit, while the voltage must be changed from 64 to 86 for charging the battery, the lamps are in series with iron wire resistances. As has already been noticed in the Digest, these consist of fine iron wires in glass tubes, filled with hydrogen. If the current increases, the resistance increases in such a way that the voltage at the lamps remains approximately 48, while the voltage of the network is increased from 64 to 86. The same system is used on the new passenger cars for D-trains between Berlin and Cologne and between Berlin and Basel, only the generating plant is constructed in a different way. It consists of a dynamo driven by a car axle. The 17-kw generator has two shunt windings and one main winding. One of the shunt windings is connected to the battery, the other to the machine terminals. In both shunt windings the current is kept approximately constant by means of iron wire resistances, so that the machine voltage remains between 64 and 86 volts for speeds beginning with 40 km. Aluminum cells are inserted between battery and machine to prevent current from flowing back from the battery to the machine when the voltage of the machine decreases. The well-known property of aluminum electrodes to allow the current to pass in one direction only, is here made use of. The system has been used for three months and has been found satisfactory. On other trains experiments have been made with lighting each car separately, a dynamo driven by the axle and one or two auxiliary batteries being provided. The total cost of first installation for the latter system has been $3.63 per candle, for the system used between Berlin and Stassnitz $5.12, for the system used between Berlin and Altona $4.62, for the system between Berlin and Cologne $3.50, and for the system between Berlin and Basel $3.75. The cost for installing gas lights in some new D-train cars amount to about $1.81 per candle. The cost of operation which can only be given after a long time of use will be smaller for electric light than for gas light and will be smaller for lighting a whole train from one source than for lighting each car separately. If interest, amortization and cost of operation are taken into account, it will be seen that the cost of electric lighting a train is considerably higher than gas lighting, if the lamps are lighted only for a few hours. The longer the time the lamps are lighted each day, the smaller will be the cost of electric lighting, and it may even become smaller than that of gas lighting. A table is given on the power consumption in the Stone system for car lighting.—*Zeit. f. Elek.* (Vienna), April 10.

POWER.

Electricity in Mines.—SCHULTE.—An illustrated description of the electric power transmission plant of the Courl mine near Dortmund, in Germany. In 1897 a small underground primary station was erected in the mine, consisting of a 90-hp steam engine coupled to a 2,000-volt, three-phase generator, which supplied several induction motors. On account of the large extension of the mine the high voltage of 2,000 was chosen. This installation was found to be very satisfactory, so that in 1900 it was decided to erect a larger primary station above ground, consisting of a 630-hp steam engine coupled to a 2,000-volt, 550-kv-amp., three-phase generator, the frequency being 50. Afterwards a second steam dynamo of 550 kv-amp. was installed and both dynamos are operated in parallel. In the mine there is water falling from one level to another, 240 meters deeper, and this has been utilized for driving a Pelton wheel coupled to a 100-kv-amp., three-phase generator. There are installed in the whole 16 motors with an aggregate capacity of 510 hp over ground and 30 motors with an aggregate capacity of 747 hp in the mine. For the underground motors the voltage is transformed from 2,000 to 215 by transformers, placed near the motors. The motors are used for driving ventilators, for hauling and various power purposes. By this means a centralization of the total power generation has been accomplished which has produced a saving of $21,000 in the year 1903, against the year 1901, which can be traced accurately, while the actual saving is larger.—*Glückauf*, April 9.

Water Power Stations.—ADAMS.—An illustrated article giving various examples from American practice. Cost of water power development depends in a large measure on the location of the electric station which is to be operated. In Burlington, Vt., the upstream wall of the station serves at the same time as a dam, there being neither canal nor long penstocks and only one wall of the power house apart from the dam. The peculiar natural conditions favorable to such a construction are seldom found. In many cases in comparatively level country a water power can be only fully developed by means of canals or pipe lines, and the generating stations cannot be located at the points where the water is diverted. In mountain districts it is generally necessary to employ rather long canals, flumes or pipe lines and an important question is whether to erect one or several stations. Whether the expense of extending conduits and pipe lines to a single generating station will more than offset the advantages to be gained thereby depends on a number of factors, but in general the smaller the volume of water to be handled and the greater its head, the more advantageous is it to concentrate the generating machinery in the smallest practicable number of stations.—*Cassier's Mag.*, April.

REFERENCES.

Electric Power in Ship Yards.—BROWN.—The conclusion of his fully-illustrated article on the application of electric power in British ship yards with special reference to the North East coast. A great many different applications are shown and described, and it is pointed out that in a comparatively short time the introduction of electric power has brought about in that district not only a complete change in the manufacturing methods of the shipbuilder, but in the characteristics of his business. "It may safely be predicted that at the end of the next decade there will not be a steam engine at work in the district driving a ship yard machine tool, and that electric power will be exclusively employed."—*Cassier's Mag.*, April.

Electricity in Mines.—GUARINI.—Two illustrated articles on electric installations in mines. The first deals with electric signalling and electric ventilators, the second with electric ore cutters, electric locomotives and hauling machines. Finally, several electric installations in mines are described.—*L'Eclairage Elec.*, April 2 and 9.

TRACTION.

Field Coils.—An illustrated account of some changes which were made with General Electric 57 field coils by the St. Louis Transit Company. They are made of flat bare copper strips wound with a strip of asbestos between the turns. Two such coils make up one field coil. They are wound side by side on a brass shell. The brass shell carrying the coil is slipped over the pole piece. It was found that frequently one or two turns would be short-circuited by contact at the edges of the copper strap and that the vibration of the coils in the brass shell often ruined the insulation. The new plan is to wind up the two sections of the field coil separately on a wooden form using the copper strap and asbestos as before; it is then taped and the coil is dipped in insulating paint and covered with a special cloth and another layer of tape. The two coils are then laid side by side, connected together and covered with canvas, micanite and red board. The whole is then dipped again in insulating paint. Instead of using

the brass shell for mounting on the field poles, two pressed-steel forms are used. As the pole piece is drawn in place the insulating covering of the coils is pressed so as to hold the field coil firmly and prevent vibration.—*St. R'y Jour.*, April 16.

Liverpool-Southport Electric Railway.—RINKEL.—A brief communication in which the author thinks that the use of a fourth rail (between the two running rails) for the return current is not suitable, since the maintenance of the track is not as good as when the running rails themselves are used for the return current, and, therefore, provided with rail joints. The author refers to the fact that in such extended railways in the United States and England a tension of 600 volts is still used, while the experience of the Wannsee road and on the Berlin elevated road have shown that an average voltage of 800 is thoroughly feasible. He asks whether the construction of motors in Germany is further developed in this respect than in England or the United States.—*Elek. Zeit.*, April 7.

REFERENCES.

Electric Railways of New Jersey.—A description and map are given of the electric railways in the State of New Jersey, particularly with reference to the lines between New York and Philadelphia. While it is now possible to travel from one city to the other by electric railway exclusively, through car trips are not yet possible owing to differences in track gauge. Most of the lines are of interurban character, but do not use such heavy equipment and attain such high speeds as is common on the interurban lines in Ohio and Indiana. The only large system is that of the Public Service Corporation, which owns the lines connecting the most important cities of northern New Jersey.—*St. R'y Jour.*, April 16.

Electric Traction in Italy.—KOROMZAY.—An article giving some critical notes on a former paper on this subject by Vaudeville. The present author appears to be somewhat more in favor of three-phase traction, compared with direct-current traction, than the former author was.—*L'Eclairage Elec.*, April 19.

Berlin and Paris.—JACQUIN.—The first part of an illustrated article on the various traction systems of Berlin and Paris.—*La Revue Elec.*, March 30.

Single-Phase Traction.—An editorial note on some American papers on this subject. Concerning Steinmetz's recent Institute paper it is said that "Reading between the lines, it would seem that Steinmetz believes the repulsion motor to be superior to the series motor for traction purposes, and in this he echoes the opinion of many electrical engineers on this side of the Atlantic."—Lond. *Elec.*, April 8.

Single-Phase Traction.—RENSHAW.—An article, illustrated with many diagrams, giving a summary of the various features of the Westinghouse single-phase railway system.—*Elec. Club Jour.*, April.

Train Lighting.—See the abstract under "Lights and Lighting."

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Paris Central Station.—DUPUY.—An illustrated description of the plant of the Est-Lumière Company, which supplies a great many towns east of Paris with electric current. The station is located at Alfortville and contains six 700-hp steam engines coupled to alternators. The capacity of each alternator is 540 kw, the voltage 5,240, the power factor 0.75, the frequency 50. The current is transmitted to the various sub-stations by six underground feeders. The transmission voltage is 5,000. In the sub-stations transformers reduce the voltage to either 250 or 110, which is the tension of the distributing system. Data are given which show that this station has been a financial success.—*L'Eclairage Elec.*, April 9.

Protection of High-Tension Lines Against Atmospheric Discharges.—BENISCHKE.—A report of a committee of the Berlin Electrical Society, giving a summary of answers received from various stations on an inquiry with regard to accidents due to atmospheric discharges during 1903. In 41 cases accidents had occurred and since in these cases all known systems of lightning arresters were used, it seems that an absolutely sure safety device does not yet exist. In a certain plant in Bohemia where accidents due to atmospheric discharges appear to occur very often, four different systems of lightning arresters were used simultaneously; nevertheless, three transformers were disabled last year. Experience seems to show that it is useful to insulate the iron frames of the machines and apparatus from earth. In various cases atmospheric discharges were observed while there was no thunderstorm and in other cases lightning arresters, insulators and line poles were destroyed by direct lightning flashes.—*Elek. Zeit.*, April 7.

REFERENCES.

Circuit-Breaker.—BRUELL.—An article, illustrated by diagrams, on a circuit-breaker for protecting electric lines against currents, dangerous by their duration and intensity, while the circuit is not broken for harmless short increases of the current. The principle is that the flux of the electromagnet which operates the circuit-breaker does not only depend upon the intensity of the current in the line, but upon the thermic conditions of the circuit. For this purpose a resistance is added to the coil of the circuit-breaker and this resistance is a function of the thermic conditions of the line to be protected. The variation of this resistance produces in the coil a variation of current which also is a function of the conditions of the circuit. The variable resistance consists of a metal with a high temperature coefficient, like iron or nickel, subjected to the heat effected by the current and placed under convenient conditions of temperature, caloric capacity and radiation. Several applications of this principle are described and exact data are given for an apparatus based on this principle.—*L'Eclairage Elec.*, April 2.

Insulation Material for Wires.—An article on the insulating material, devised by Hackethal, which has been repeatedly noticed in the Digest. It is formed of a vegetable tissue impregnated with linseed oil and minium and used to good advantage in Germany for telephone wires, especially in the neighborhood of tramway lines. It has also given good results in chemical plants on account of its resistivity against the corrosive action of an atmosphere saturated with acids. Boehm-Raffay recommends the same insulating material for transmission lines and remarks that when too high a current flows through the wire the insulation may be dried out and may even carbonize, but will not burn. Wires of 6 mm. diameter were supplied for several hours with a current density of 50 to 60 amp. per sq. mm., but did not show the slightest dangerous phenomena.—*L'Elec.*, April 2.

REFERENCE.

Telephone Cables.—SCHMIDT.—An illustrated description of the methods used by various manufacturers for making telephone cables with a plurality of wires with air insulation.—*Zeit. f. Elek.* (Vienna), April 10.

ELECTRO-PHYSICS AND MAGNETISM.

Emanation from Radium.—MCCLELLAND.—A paper in which the author remarks that the emanation produced by radium has been much studied and many of its properties are known, but it had so far not yet been definitely settled whether or not the emanation particles are charged. The author has tested this point and has found that the emanation is not charged. This result has a bearing on our conception of the manner in which the radium atom breaks up. The radium atom certainly gives off positively charged particles—the α rays. The emanation particles cannot be what remains of the atom after the emission of one or more α rays, because in that case it would be negatively charged. The atom must have parted with an equal negative charge either by the emission of negative particles or in some other way.—*Phil. Mag.*, April.

REFERENCES.

Radioactivity.—BECQUEREL.—The first part of an article on the radioactivity of matter. In the present installment he discusses the discovery of the radioactivity of uranium, and the radiation from uranium.—*L'Eclairage Elec.*, April 2.

Alternating-Current Diagrams.—KARAPETOFF.—The first part of an illustrated serial on applications of alternating-current diagrams. The present installment gives elementary examples.—*Elec. Club Journal*, April.

Alternating-Current Working.—GUMP.—The first part of what will probably become a long serial illustrated by diagrams in which the author intends to treat in a simple manner with the fundamental principles of alternating-current engineering.—*West. Elec.*, April 9.

Radiation from a Circular Circuit.—ORR.—A mathematical note on the radiation from a perfect conductor in the form of a very thin circular ring, which carries an alternating current.—*Phil. Mag.*, April.

ELECTRO-CHEMISTRY AND BATTERIES.

Calcium Carbide.—MOISSAN.—A French Academy note on a new experimental process for making calcium carbide. Metallic calcium combines with lamp black at any temperature above red heat. In any electrolytic process, therefore, where calcium is produced in contact with carbon at red heat, calcium carbide is formed. The author

bases a new carbide process on this consideration, which, however, appears to have no commercial value, since the carbide obtained is firmly embedded in a fused mass of calcium chloride and fluoride. A carbide crucible which serves as the positive pole is filled with calcium chloride fused by means of a small electric arc. A vertical rod of graphite serves as a negative electrode. The chloride is put in gradually and after the first fusion electrolysis is carried out by means of a current of 10 to 15 amp. at 120 volts. Chlorine is given off freely and after an hour the process is stopped and the crucible broken. Under the crust is found a mass with a crystalline fracture. The central portion dissolves in water and evolves a mixture of gases containing some 14 per cent. of acetylene, the rest being hydrogen. The process is greatly improved by mixing the chloride with a quarter of its weight of fluoride, which makes the mixed mass more fluid and the conduction of the current more regular. The amount of graphite obtained is small, but it may be increased by adding to the liquid a coarsely-powdered mass of petroleum coke.—*Comptes Rendus,* March 14; Lond. *Elec.,* April 8.

REFERENCE.

Ferro-Silicon.—Amberg.—Ascherman has claimed that by treating a mixture of iron sulphides with quartz in an electric furnace under proper conditions, a reaction may be obtained, yielding ferro-silicon and sulphur dioxide. This would represent an important progress, since the use of carbon as reducing agent would be eliminated. The present author has made an experimental study of this problem, but has found that there is very little hope for the conduction of a process like that of Ascherman on a commercial scale.—*Stahl und Eisen.,* April 1.

Units, Measurements and Instruments.

Comparison of Capacities.—McClelland.—An application of radioactive substances for a simple and accurate method for comparing capabilities. The method is suitable for the determination of capacities of any magnitude down to a few micro-microfarads or even less. The method is based on the fact that the ionization current that can be obtained by the use of a radioactive substance like uranium is extremely constant and can be made so small that the time taken to charge a condenser by it can be accurately measured. This small constant current is used first to charge one condenser to a given potential; and then a second condenser is charged to the same potential, and the time taken in the two cases observed, so that we get the ratio of two capacities by simply observing two intervals of time. It is not necessary to have a supply of radium; uranium is even better in some respects and uranium is to be found in every laboratory. In Fig. 4 *A* and *B* are two insulated plates, one of which, *B*,

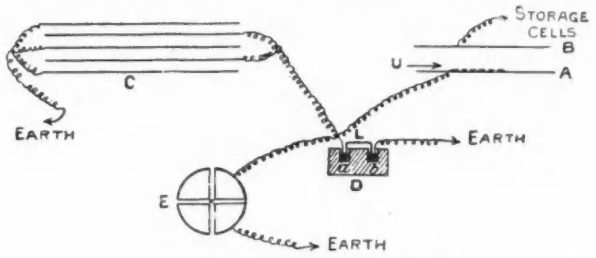


FIG. 4.—COMPARISON OF CAPACITIES.

can be joined to one terminal of a battery of small storage cells, the other terminal of which is to earth. The battery may consist of 100 or more small test-tube cells, so that *B* can be kept at 200 volts or higher. A few grams of uranium nitrate are spread on a sheet of paper and placed on the plate *A*. The radiation from the uranium ionizes the air between *A* and *B;* and so *A* gradually rises in potential if insulated, supposing *B* to be positive. The ionization current thus obtained between two plates increases at first as the potential differences between the plates increases. But when this potential difference is made sufficiently great, the current attains a maximum and does not further increase, for further increase of potential difference between the plates. If, then, *B* is kept at a sufficiently high potential, small changes in this potential, due to the potential of the battery falling, will produce no effect; and again, in making an observation, the potential of *A* need never change by more than one volt, so that there is no trouble in keeping a constant current to the plate *A*. *C* is one of the condensers being compared and *E* is a quadrant-electrometer. *D* is an insulating block of paraffin, containing two mercury cups, *a* and *b*, one of which is connected to earth. A connecting piece, *L*, joins the mercury cups and can be lifted out and lowered again from a distance. As soon as *L* is lifted out, *A* and *C* and *E* begin to charge up; and the time is observed during which the spot of light moves, say, over 100 scale divisions. An exactly similar experiment is made with a second condenser, C^1, instead of *C*. If the intervals of time are *t* and t^1, respectively, then $C + c$ to $C^1 + c = t$ to t^1, where *c* is the capacity of the electrometer, the condenser, *A B*, and the connecting wires, and can be determined in terms of *C* by taking an observation with *C* joined of as shown in Fig. 5, and then an observation with *C* disconnected so that only *c* is charged.—*Phys. Mag.,* April.

Optical Ammeter.—Orlich.—A description of a method for measuring currents which is employed at the Reichsanstalt for testing alternating-current ammeters. It consists in heating to incandescence a sheet of platinum foil by a continuous current and an alternating current in succession. If the effective value of the alternating current equals that of the continuous current, the amount of heat developed in the platinum foil is the same in both cases, and if the emission is also the same, the sheet must attain the same temperature in both cases. The equality of temperature may very conveniently be tested by Holborn and Kurlbaum's optical pyrometer. An image of the glowing platinum is projected by means of a lens upon the filament of a small incandescent lamp, which is observed through a second lens. The current feeding the lamp is so regulated that the filament apparently disappears in the bright background. Special provision has to be made for constancy of temperature. As regards radiation, it is kept constant by allowing the platinum to radiate into the open air, and the conduction of heat is kept constant by perforating the electrodes and supplying them with a stream of cold water. The temperature imparted to the platinum sheets varied from 400 to 1,400°. At higher temperatures the method loses in sensitiveness, and the platinum begins to evaporate. The author quotes a number of tests of commercial ammeters. A Kelvin hectoampere balance with subdivided copper leads gave correct readings, but a kiloampere balance containing massive leads required an alternating-current 5 per cent. stronger than the corresponding direct current to produce the same temperature.—*Zeit. f. Instrumentenk.,* March; Lond. *Elec.,* April 8.

Testing Induction Motor Windings.—Garcelon.—An illustrated article in which the author describes tests of induction motor windings. The test is based upon the fact that any error in the winding will destroy symmetry of the magnetic field produced by the winding when single-phase alternating current is passed through it. This, in turn, will affect the impedance of the winding. The first test to be made is always to determine whether or not the winding is correct. This is done by observing the impedance drop across each phase. If these readings indicate an error, then a second test—or location of the error—must be made. The point where the fault exists is indicated by an irregularity of the field-form, which may be investigated by moving an exploring coil around the core. A simpler way is to measure the drop from stub to stub, the stubs being easily exposed by removing the tape. These drops should be alike for each coil symmetrically located with respect to the poles. The author shows how such mistakes as a reversed phase or a reversed group affect the first part of the test and locate themselves at once without an application of a second or locating test. A suitable switchboard for making such tests is described and illustrated.—*Elec. Club Jour.,* April.

Hot-Wire Voltmeter.—Threlfall.—An illustrated description of a new form of sensitive hot-wire voltmeter. The chief peculiarity of the instrument is in regard to the means adopted for securing uniformity of tension of the fine silver wire. The active wire is carried between two adjustable supports, one of which is insulated from the rest of the apparatus. The other support can be moved to and fro in the direction of the wire by means of a micrometer screw. The wire is pulled down at the center by a microscopic hook and spiral spring insulated from the base. A small mirror hinged on a wire stretched alongside rests on the head of the hook. As the active wire heats up, the hook descends and the mirror is tilted downward. There is a small incandescent lamp in the lid of the box enclosing the instrument, and a scale opposite a slot in the front of the case. By means of a prism and lens an image of the filament is thrown on the screen by the mirror, and by turning the micrometer screw this image can be brought to any desired point. Small voltages can be read off at once on the scale, but larger ones are compensated by working the screw.—*Phil. Mag.,* April.

New Books.

DIZIONARIO TECNICO IN QUATTRO LINGUE. II. Tedesco, Italiano, Francese, Inglese. 2 Edizione. Ing. Edoardo Webber. Milan: Ulrico Hoepli. 611 pages. Price, 6 lire.

This is a handy little volume of technical expressions in four languages—English, French, Italian and German—for it is more than simply a dictionary. It is arranged alphabetically, each two pages being printed in four parallel columns, thus: Deutsch, Italienisch, Französich, English. The volume for each language has the phrases alphabetically arranged in the first left-hand column, while the corresponding translations in the other three languages are opposite in the corresponding headed columns; for example, the German volume has the German phrases arranged alphabetically on the left hand of the page, and thus to complete the set one must procure all four volumes.

The arrangement is exemplified by the following quotation:

"Ammoniakgasmotor: Motore ad ammoniaca: Moteur à gaz ammoniac: Ammoniacal Gas Motor."

The book is of convenient size, substantially bound and of excellent typography. It will be found an exceedingly handy volume for those who employ scientific technical phrases.

TRANSACTIONS OF THE AMERICAN ELECTROCHEMICAL SOCIETY. Vol. IV. Philadelphia: American Electrochemical Society. 192 pages.

Of all the applications of electricity, that of electrochemistry is the youngest and yet has perhaps made the most marvelous development. This is evidenced by the fact that the bulk of the output of the Niagara power plant is employed in electrochemical operations. Had it not been for electrochemistry aluminum would still be a precious metal, nor would carborundum or acetylene have become commercial possibilities. While electricity is the agent which makes these new commercial fields possibilities, it is only by means of the patient investigation of both electricians and chemists that the ability to so employ it has become feasible. No wonder, therefore, that the Electrochemical Society is now one of the most important scientific bodies, or that their proceedings should arouse the liveliest interest.

The present volume reports the transactions of the meeting which took place at Niagara Falls during the latter part of September, 1903. In many respects the papers presented are a marked contrast to those of other professional societies, for they are so brief as in many cases to hypothecate for comprehension an amount of special knowledge much beyond that of the average reader. The volume contains sixteen papers, among which the following appear to be of special interest: "Note on Some Theoretical Considerations in the Construction of Resistance Furnaces," by H. A. Fitzgerald. This paper briefly describes some of the conditions governing resistance furnaces and presents data valuable in designing and proportioning. "Electrolytic Copper Refining," by W. D. Bancroft, contains a quantity of data bearing directly upon the cost of the refinement of copper by electrolysis. A "Note on Berthelot's Law Relative to the Electromotive Forces of Cells," by C. J. Reed, together with Mr. Roberts' contribution on the "Electrical Properties of Free Ions in Solution," is notable as bearing upon the theory of the electrolytic cell.

To even mention all of the contents of the volume would transcend our space limit, but the reader who is interested in and desires to be fully posted in electrochemical affairs should by no means fail to secure this set of papers.

A TREATISE ON FRICTION AND LOST WORK IN MACHINERY AND MILL-WORK. By Robert H. Thurston. New York: John Wiley & Sons. 430 pages, 77 illustrations. Price, $3.00.

No engineer can take up this volume without mingled feelings of affection and sorrow. Of affection because Dr. Thurston of all scientific writers most endeared himself both to the student and professional man, and of sorrow because the hand which has produced so many works has now forever laid the pen aside. The "Treatise upon Friction and Lost Work" is so well known to the entire engineering profession that to describe even this latest edition is almost superfluous. The first edition, which appeared nearly 20 years ago, was the earliest attempt to give a systematic and scientific explanation of the doctrine of lubrication, and to so guide the man in the engine room that he might select and apply lubricants with such discrimination as to produce the most successful results. From time to time succeeding editions have built upon the foundation laid by the first one, rearing a structure which has endeavored to keep pace with the art of lubrication, to embody the changes in practice which have occurred and to recommend both methods of applying lubrication and new lubricants. It is perhaps hardly exaggeration to say that Dr. Thurston's treatise laid the foundation of the modern method of lubrication now almost universally adopted in large plants, viz.: that of providing a complete system of flowing lubricant which is pumped through the bearings of every machine, returned to a filtering apparatus and again circulated after being clarified.

The present volume elaborates somewhat upon previous editions by containing a complete résumé of the improvements and changes in the practice of lubrication which have occurred during the last five years. The chapters on the method of applying lubricants, the testing and inspection of them, and the machines which have been developed for this purpose have particularly undergone modification and modernization, and as a result thereof the data relating to the action of lubricated surfaces have been correspondingly expanded and increased both in quantity and in quality.

The chapter upon the "Finance of Lubrication" will be found by the power station and mill owner to be of the greatest value and is unique in the literature of lubricants. Finally, a chapter upon "Recent Investigations and Conclusions" embodies some novel methods of plotting the results of experiments and brings the volume thoroughly into touch with modern practice.

TECHNICAL MECHANICS. By Edward R. Maurer. New York: John Wiley & Sons. 382 pages, 250 illustrations. Price, $4.00.

This volume is the latest addition to a somewhat extensive library of college text-books, of which Weisbach and Rankine were the illustrious and revered progenitors. In his preface Prof. Maurer has defined his object in stating that the work is not a treatise upon pure or applied mechanics, but a "Theoretical Mechanics" for students of engineering. A perusal of this volume fully sustains this assertion, for in many cases the mixture of pure theory with attempted applications to practice appears abrupt and harsh. Some of the definitions strike one peculiarly, for example: "An action of one body upon another which changes or which exerted alone would change the state of the motion of the other body is called a force." One ordinarily would hardly include the operations of heat and electricity, which are customarily spoken of as forces, within such a definition, but the author proceeds to explain that inasmuch as it is necessary to postulate an intervening medium for the operation of a force, this medium may be termed a body.

Throughout the entire work there is a distinctly German flavor and one constantly encounters German methods of analysis and German ways of reasoning, which, while unquestionably of value, are likely to jar a little upon the American reader. In his analysis of the subject of mechanics the author classifies as follows:

1. Mechanics: { Kinematics; Dynamics { Kinetics; Statics }

and further proceeds to state that statics is that portion which deals with uniform motion. To the bridge builder such a definition will appear somewhat forced, because while theoretically we are all aware that the ultimate particles of even the mosit rigid solids are probably in motion, yet the constructor usually regards his tension and compression members as something as solid and immovable as he can make them, and certainly hopes that they will never escape from their preassigned positions and go gyrating off into space while a limited express train is traveling across the track which they sustain.

There are three sections—Statics, Kinematics and Kinetics—and these are further subdivided into 15 chapters, which, under the heading of Statics treat of Force, Equivalence of Force System, Center of Gravity and Centroid, Attraction and Stress, General Principles of Equilibrium, and the Application of the Principles of Equilibrium.

Under kinematics, the rectilinear motion of a particle is first considered, then curvilinear motion and motion of a rigid body.

Kinetics is sub-divided into motion of a particle and of a system of particles, translation of a rigid body, rotation, work and energy, and finally impulse and momentum.

A quartette of appendices, of which the first is a brief explanation of the principles of vectors followed by a dissertation on rates of motion, the dimensions of units and moment of inertia, complete the book.

The volume is clearly and tersely written. For each problem, as far as possible, both a graphical and analytic analysis is given. The illustrations are well selected and present the various subjects clearly. From a theoretical standpoint it is attractive, but when one lays it down the academic flavor is so strong that one is inclined to wonder whether a student thereof will not be so afflicted with theoretical hydrocephalus as to be unfitted for the every-day experience of the shop or of the railway.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Twenty-sixth Convention. Published by order of Executive Committee. New York: James Kempster Printing Company. 221 pages, illustrated.

It is the fashion for those who are interested in commercial developments which lie along technical lines, to hold occasional conventions at which those interested in the particular branch represented can meet and interchange ideas. One of the earliest organizations of this kind is the National Electric Light Association, and indeed this body has almost set the pace for other similar associations to follow.

The volume in hand is the report of the *Proceedings* at the last convention, an examination of which shows a series of papers partly scientific and partly commercial, but all apropos to the best development of the particular industry. The matter presented is so carefully considered, so well arranged, so thoroughly pertinent to the questions of the day, so generally helpful, and, withal, so dignified in tone as to make one wonder at the contrast presented between the National Electric Light Association and some of the younger associations. Naturally, the present volume commences with the president's address, which is chiefly a perusal of the work accomplished by the organization during the past year.

This is followed by Mr. T. C. Martin's report upon the "Electrical Progress of the Year," a document that is replete with statistics and will put the reader perfectly *au courant* with electrical development in 1903. The next paper is a report upon office methods and accounting by Mr. W. M. Anthony, which is strictly a commercial contribution. Some one has tritely remarked that "any business can be made to pay if you know what it costs, while no business can be made to pay if you don't." This is the keynote of Mr. Anthony's report. He deals with the methods of accounting, particularly with the employment of various mechanical aids, such as the addressograph, comptometer and a number of other mechanical devices, which are aids to the bookkeeper and statistician. The author shows a number of forms applicable to electric light and street railway stations which may be studied with much profit, and, indeed, though the report is addressed particularly to the electrical fraternity it is well worth the study of any business man.

The paper on "Boiler Efficiencies," by A. Bement, and the one on the "Application of the Four-Ampere Series Alternating Arc Lamps" are particularly worthy of study to those who are interested in these subjects. "The Young Engineer in the Electric Light Plant," by Charles F. Scott; "Tactful Relations with Customers," by John W. Ferguson; "Relations with Employees," by Arthur Williams, and "First Aids and Appliances," by Dr. J. D. McGowan are not technical papers in any sense of the word, but are addressed to the business side of electric lighting and thus give to the proceedings of this Association a breadth which the transactions of purely technical societies usually lack. The paper by Dr. McGowan would have had much more value if, previous to its preparation, he had consulted the very considerable literature on the subject. His presentation is decidedly amateurish in view of the audience addressed.

In a report upon "District Steam Heating," by John W. Glidden, and in a paper on "Salt as a By-Product," by Alex. Dow, some methods whereby central stations may increase their income by the utilization of the so-called by-products are interestingly discussed.

Of all the papers the report in appendix A upon "Decorative and Sign Lighting," by Arthur Williams, is the most elaborate, for it is profusely illustrated by a series of some of the finest half-tones that one could imagine. Undoubtedly, however, the most valuable feature of the volume is the "Question Box," which department should be of immense benefit to the members of the Association, whether as querists or for the general mass of practical information conveyed.

BOOKS RECEIVED.

MANUALE PRACTICO PER L'OPERAIO ELETTROTECNICO. By G. Marchi. Milan: Ulrico Hoepli. 337 pages, 189 illustrations. Price, 2.50 lire.

DIE ELEKTROLYTISCHE RAFFINATION DES KUPFERS. By Titus Ulke. Halle: Wilhelm Knapp. 152 pages, 86 illustrations. Price, 8 marks.

Carcano Power Factor Indicator.

BY GUIDO SEMENZA.

What may be termed a novel feature in the instrument to be described below is that it is rather a power factor meter than a power factor indicator, since it affords a means for taking accurate data; whereas, the ordinary power factor at the present time does not give indications of any great accuracy.

The new instrument is based on a reduction to zero method, which, while not permitting the following of sharp variation, facilitates, on the other hand, the realization of a relay recording apparatus. The instrument comprises a disc which can freely rotate under the action of a shunt and of a series set of coils, in connection with which a special rheostat box is used. The way to proceed in taking measures is as follows:

The rheostatic resistance is varied until the rotating disc is brought to rest, when the values of the resistances give the corresponding value of the power factor; and since to each position of the rheostat there corresponds one value of the power factor, the rheostat is directly graduated in power factor values. The principles on which Mr. Carcano, electrical engineer in charge of the Milan Edison Company's testing department, has designed his method, are as follows:

In an apparatus like the one shown in Fig. 1, consisting of a disc which can rotate under the influence of a revolving field due to a system of coils, the motion will cease the moment all the currents flowing through the different coils have the same phase; therefore, if a number of coils are connected in series in the circuit, and another number of them in shunt, the motion will cease when the current, i, which flows through the coils connected in shunt, are in phase with the current, I, of the principal circuit. Now, for a given shunt coil having such a ratio between reactance and resistance as to cause the current, i, to lag by an angle Θ behind the e.m.f. applied to its ends, such condition will be realized when the principal current, I, lags behind the e.m.f. acting in the circuit, by an angle $\phi = \Theta$. (See Fig. 2.)

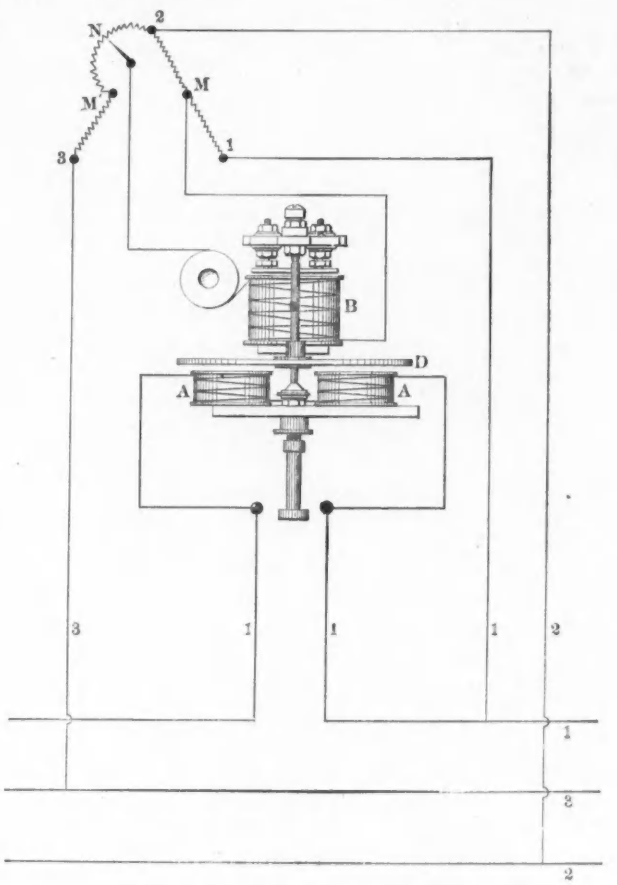


FIG. 1.—DIAGRAM OF APPARATUS.

It follows that if we have at our disposition a coil or a number of coils in shunt, in which the ratio between reactance and resistance, or the angle Θ, can be varied, it is quite possible to balance any value

of ϕ. We can, therefore, for any value of the power factor, obtain a zero position of the disc by altering the value of Θ. If the method of altering the angle Θ enables us to know at any moment its value, we can at once read the angle Θ, corresponding to the angle ϕ. It is possible to obtain for any value of ϕ the current I in phase with i, without making an alteration in the shunt coils by applying to them, for every value of ϕ, a voltage taken from the opposite points of the circuit, in such a manner that the displacement between such voltage and the principal current is exactly equal to the angle $(\phi - \Theta)$, but of opposite sign. (See Fig. 2.)

In the case of polyphase currents the method is particularly easy and simple. For instance, with three-phase currents, the following arrangement can be applied (Figs. 1 and 3): The ampere coils, A, of the system are put in circuit with the wire, i; B are the coils in shunt; A and B are arranged in such a manner as to produce the rotation of a disc D, so long as a difference of phase exists between

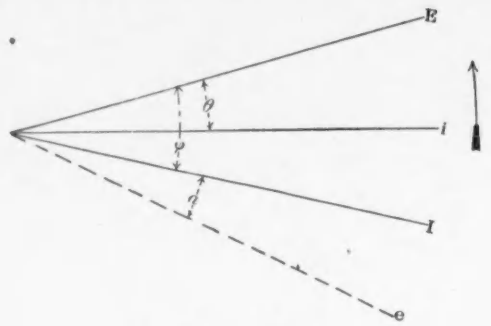


FIG. 2.—ANGLES OF LAG.

i and I, the rotation ceasing when i is in phase with I. Between the wire 1 and 2 of the system a resistance is inserted of which M is the middle point, and between 2 and 3 another resistance is inserted of equal value, but divided in two portions, one being a fixed resistance and the other a rheostat having a certain number of contact points. The shunt coils are connected to M and the sliding handle of the rheostat.

By changing the position of the rheostat we change the phase angle between the e.m.f. acting on the shunt coils and the current I, and the limits of this change are a lag or a lead of 30°. Then the current i, which flows through such coils will vary from a leading value of $30° - \Theta$ to a lagging value of $30° + \Theta$ with respect to I; and through the rheostat N we are able to obtain i in phase with I; or in other words the stoppage of the movable disc for any value of ϕ, comprised between $30° - \Theta$ and $30° + \Theta$, leading or lagging.

As long as i is slightly lagging or leading with respect to I, we will have motion on one or the other direction. In practice the sensibility is very high, since a slight variation in the load of an induction motor arising from its power factor is sufficient to impart a decided motion to the disc, once the position of equilibrium is reached. To every contact point of the rheostat N—that is to say,

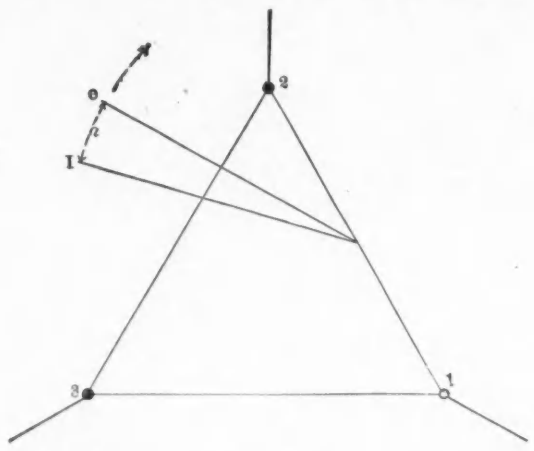


FIG. 3.—DIAGRAM FOR THREE-PHASE CIRCUITS.

to every ratio of the resistance inserted between N and 2 and the one inserted between N and 3—the equilibrium will correspond to a given value of ϕ. In this way a proper graduation or scale of power factor can be established for every value of the resistance, and in practice it will be sufficient to move the contact lever on the contact points forward or backward to obtain the stoppage of the movable disc, and the power factor will be the one shown at the resistance point in contact with the lever.

We thus have an indicating apparatus which can easily also be made a recording apparatus. In fact, if the disc instead of being free is kept to a zero position by a system of springs, and when forced out of such a position, can close the circuit of a relay recording instrument, it is easy to arrange that the motion of the recording pointer will change the position of the rheostat until the disc has taken its zero position. This principle is successfully applied in the Olivetti recording wattmeter.

Mr. Carcano's method and instrument are quite a novelty in the field of alternating-current measurement, and no doubt they will be of great service in testing induction motors and in the control of synchronous motors and converters.

Equipment for New Wanamaker Store.

The huge new Wanamaker department store to be built between Eighth and Ninth Streets on Broadway, New York, will be equipped with one of the largest and most elaborate isolated electric lighting plants in the country. The plant will be a three-wire one and will have many new features. Its capacity will be 1,800 kw. There will be 1,700 arc lights and 6,000 incandescents of 16-cp capacity.

The generators will be six in number, Westinghouse engine type, direct-connected, of 300-kw capacity each. The engines will have a capacity of 450 hp each and are to be horizontal cross compound, automatic cut-off, built by the Buckeye Engine Company, of Salem, Ohio. All couplings are to be made with galvanized iron. The boilers are to be Babcock & Wilcox. The motors will aggregate about 350 hp in capacity. They will be of Westinghouse make and are to range in size from 10 hp to 60 hp. A 10-hp motor and a 25-hp one will be used to drive disc fans, while a 40-hp machine will operate an exhauster. A 20-hp motor will drive a house pump and a 10-hp will work a brine pump. The feeder to the ejecter compressors will be driven by a 20-hp motor. The bilge and drinking water pumps will be 10-hp and 7½-hp motors. A 10-hp machine will drive the temperature regulator, while 25-hp, 45-hp and 60-hp motors will operate fans. The lamps will be operated at 125 volts. The motors will be driven at 250 volts.

An extra heavy conduit will be used in the plant. It will weigh 86 pounds to the 100 ft. The wires will be enclosed in ½-in. pipe, of which there will be several miles. The conduit contract will be undertaken by the Safety Armorite Conduit Company, of Pittsburg, Pa. The panel boards will be of special design.

The Thompson-Starrett Company, 51 Wall Street, New York, have secured the contract for the construction of the building, including the plant. D. H. Burnham & Co., Chicago, are the architects. Mr. Charles Wilks, the Burnham Company's chief engineer, designed the electric plant. The contracts for equipment, etc., are being awarded through H. D. Babbit, the electrical engineer of the Thompson-Starrett Company, who was formerly associated with the Chicago Edison Company. The plant will entail an expenditure not far short of $200,000.

Automobile Parade.

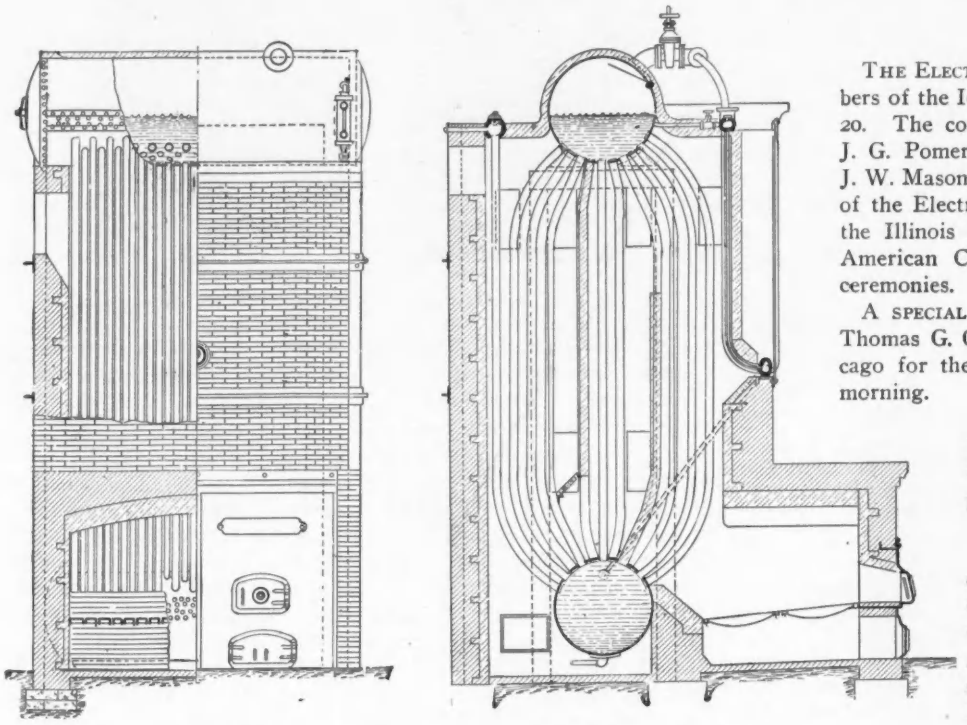
An automobile parade will be made in New York City, April 30, under the auspices of the Automobile Club of America. The head of the parade will start in front of the club house on Fifth Avenue, the officers of the club with their invited guests being in the van. Mayor McClellan will ride at the head of the procession, and at the end of the run he, with other officials, will review the parade from the windows of the club house, after which the parade will disband. The time occupied by the parade will be from one and one-half to two hours. It will start at 2 o'clock promptly, and by 4 o'clock the last car will probably have passed the club house. The parade will be divided into sections, according to the variety of the machines. In the first section will be the guests and club officers, after which will come American gasoline runabouts, American gasoline touring cars, racing cars, foreign gasoline cars, electric runabouts, electric pleasure vehicles, steam pleasure vehicles, electric cabs and hansoms, and commercial vehicles. No notices of any kind will be allowed on the vehicles.

Milne Water-Tube Boiler and Superheater.

The accompanying illustrations show elevations and sections of the Milne water tube boiler, and also in figure to the right, an elevation of the Milne superheater connected to the boiler. The boiler is a simple combination of four parts, namely, an upper and lower drum, connected by a number of sections of 4-in. seamless drawn-steel tubes, arranged in staggered effect, to which is coupled an independent feed water section composed of a single staggered row of tubes. The design, it will be seen, avoids the numerous parts and complications so prevalent in steam boiler practice and reduces the weight of material to a minimum. Materials only necessary to generate steam efficiently are used, and with the best fuel economy.

The tubes are all curved to a five-foot radius. There are five different bends in a complete set of tubes and the front and back rows are interchangeable. The tubes are spaced and arranged so that any of them can be removed and replaced without disturbing the brick work or the tubes adjoining.

The feed water section is composed of a single staggered row of 4-in. tubes, extending completely across the back of the boiler, their upper ends expanded into an independent header, not connected with the upper drum, which receives the feed water. Feed water is not admitted to the upper steam and water drum. This feed water



FRONT AND SIDE SECTIONAL ELEVATION OF WATER TUBE BOILER.

section takes up considerable heat that otherwise would be wasted, as it presents a cool surface to the escaping gases. It also adds another element of safety in protecting the drum plates from the influence of the feed water, particularly in case of low water, and much drier steam is produced, as fluctuations in temperature due to variable feed supply do not occur.

The furnace design and disposition of heating surface will, with intelligent firing, produce the most efficient combustion. The fire brick arch covering the furnace maintains the high temperature required to ignite and burn the fuel gases, and as the heating surface is situated at the back of the furnace and bridge wall, the highest furnace temperature is maintained, and the temperature of the fuel gases not reduced until combustion is completed.

The boiler is constructed of wrought steel material throughout, and does not contain flat, stayed or inaccessible surfaces, all surfaces being cylindrical, of moderate diameters, and accessible in the most direct manner for every purpose. The vertical position of the tubes prevents the collection of dust and ashes, thereby insuring a rapid and uniform transmission of heat; and as the gases of combustion travel about 70 ft. over the heating surface, and finally over the feed water section before escaping, the highest fuel economy is insured.

The tubes can be cleaned with greater ease, and with less expense than straight tubes. Scaffolding or other structures are not needed, and there are no hand-hole plates to remove and replace. One manhole gives access to every tube in the boiler, and any of the mechanical rotary cleaners, now so extensively used, will clean them in the most direct manner.

The Milne superheater, shown in the figure to the right, is of the most simple form, being composed merely of an upper and lower steel header, into which the superheating tubes are expanded, the flexibility of the system amply providing for expansion and contraction. Being situated in the front of the boiler, it is directly accessible for any purpose, and in case of serious derangement can be removed entirely while the boiler is under pressure. Equally important is the fact that the degree of superheat can be varied to suit all practical working conditions.

The makers claim that the simplicity of the complete boiler and superheater guarantees the greatest ease and efficiency in operation and the lowest cost for maintenance; and that the large water holding capacity and ample steam liberating surface insure steady water level and perfectly dry steam.

These boilers and superheaters are constructed in all sizes up to 1,000 hp and for any steam pressure, the design permitting ample grate area for capacities far in excess of the rating. They are made by the Milne Boiler Company, 95 Liberty Street, New York.

Iowa Convention Notes.

The Electrical Supply Men gave a smoker to the members of the Iowa Electrical Association the evening of April 20. The committee in charge of the arrangements were J. G. Pomeroy, of the Adams-Bagnall Electric Company; J. W. Mason, of the Central Electric Company; P. R. Boole, of the Electric Appliance Company, and N. G. Harvey, of the Illinois Electric Company. Thomas G. Grier, of the American Circular Loom Company, acted as master of ceremonies.

A special car of Chicago supply men arranged for by Thomas G. Grier, W. S. Goll and W. H. Colman left Chicago for the convention Tuesday night, returning Friday morning.

The National Electric Company, Fort Wayne Electric Works, and Illinois Electric Company made parlor exhibits of light apparatus and specialties.

The following supply and manufacturing concerns were represented: American Steel & Wire Company, American Circular Loom Company, Thomas G. Grier; Allis-Chalmers Company, E. Dryer; American Electric Works, American Transformer Company, P. T. Ackerson; Adams-Bagnall Electric Company, J. G. Pomeroy; Bullock Electric Manufacturing Company, Bryan-Marsh Electric Company, J. S. Corby, J. L. Barnard; Central Electric Company, J. W. Mason, J. G. Ball, C. A. Filker; Crescent Company, Albert Meyer; Crouse-Hinds Company, F. F. Skeel; Columbia Incandescent Lamp Company, J. G. Boyd; Dearborn Drug & Chemical Company, Diamond Meter Company, Electric Appliance Company, P. R. Boole, Leon Bly; Ewing-Merkle Electric Company, Electric Storage Battery Company, J. A. White; Ft. Wayne Electric Works, Garton-Daniels Company, W. P. Cosper; General Electric Company, W. H. Colman, G. A. Seabury; General Incandescent Arc Light Company, Francis Raymond; Gould Storage Battery Company, E. L. Draffen; Guarantee Electric Company, Hazard Manufacturing Company, Heine Safety Boiler Company, James H. Harris; Illinois Electric Company, A. H. C. Dalley, N. G. Harvey, H. W. Johns-Manville Company, F. E. Johnson; Macomber & Whyte Rope Company, Manhattan Electrical Supply Company, W. N. Matthews Brothers, Monarch Electric & Wire Company, New York Insulated Wire Company, Nungesser Electric Battery Company, A. D. Trempe; National Electric Company, A. P. Peck; National Conduit & Cable Company, F. B. Switzer; Nebraska Electric & Fixture Company, A. G. Munro; Nernst Lamp Company, Robert P. Payne; Osborne Flexible Conduit Company, C. B. Roulet, I. A. Bennett; Pass & Seymour, J. S. Jackson; Phelps Company, I. A. Bennett; John A. Roebling's Sons' Company, W. H. Schott, J. C. Hormung; Sawyer-Man Electric Company, A. Sorge, Jr., & Co., E. Emery, George Searing, C. A. Ross; Standard Underground Cable Company, Stan-

ley Instrument Company, F. J. Alderson; Standard Electrical Manufacturing Company, R. W. Loose; Tri-City Electric Company, I. N. Butterworth; Wesco Supply Company; Waterloo Electric Supply Company, L. G. Hopkins; Westinghouse Machine Company, J. B. Wilkinson; Westinghouse Electric & Manufacturing Company, W. R. Pinckard, H. G. Peticolas, Arthur Huntington, A. M. Miller; Western Electric Company, M. R. Lash.

Regulating and Reversing Controllers for Machine Tool Service.

The use of individual motors for driving machinery has grown in general favor as the advantages derived from an independent source of power for each appliance have become recognized. Shunt and compound variable-speed, direct-current motors especially adapted for such service have been designed and suitable controllers for applying the power to the work in hand and properly regulating the speed of the machinery are thus a prime requisite.

A line of controllers, particularly adapted for use with independently-driven machine tools is manufactured by the Westinghouse Electric & Manufacturing Company and known as types V and W, the assortment being comprised of over 600 different sizes and capacities, to cover all the requirements of service. The type V controllers are used upon two-wire, single-voltage circuits, eight forward speeds and four reverse speeds being obtained by resistance in the shunt field circuit. In the type W, used upon three-wire, two-voltage circuits, the speed variations are obtained by means of the two voltages as well as the shunt resistance, provision being made for six forward speeds on the lower and nine on the higher voltage, and six reverse speeds on the lower voltage. Experience has proven that this number of speed variations is the best possible for general use, and affords all the differences in speed required in service.

The type V controllers are ordinarily adopted when a speed variation of 2 to 1 is required, and the type W for variations of 4 to 1, although other variations may be obtained as desired, each installation being separately considered and the controller used which is best adapted to the motor with which it is to be used. The successive intermediate speeds are arranged in practically geometrical progression, but extra leads are provided by the use of which the owner may make such changes as he desires.

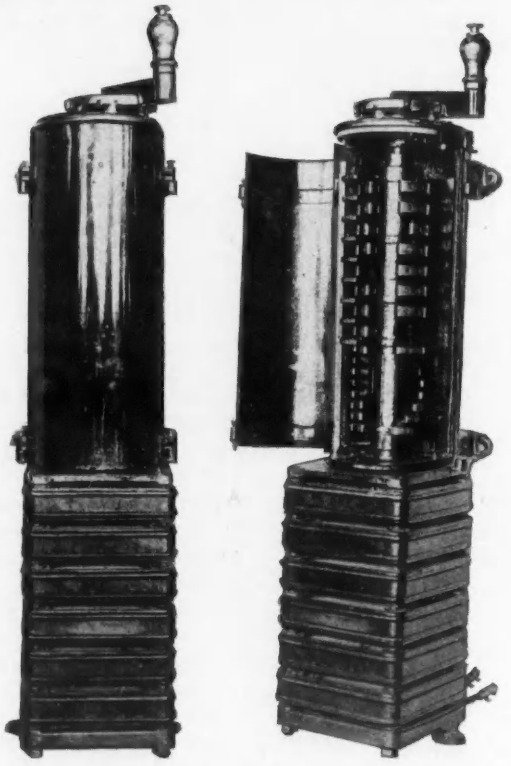


FIG. 1.—CONTROLLER FOR TWO-WIRE, SINGLE-VOLTAGE CIRCUITS.

In general structure, these controllers are based upon the most modern and improved types of Westinghouse design, insuring reliability and long life regardless of hard usage. They are thus practically independent of their surroundings, and give satisfactory service under all conditions. The drum is made of metal and secured to an insulated shaft. The contact strips are of hard rolled copper. The fingers are also made of hard rolled copper and provided with lock nuts and adjusting screws. All parts are liberally proportioned and are made easy of access. The cover can be removed by withdrawing with the fingers the pins which hold it in place, and access to the leads is quickly obtained by removing the strips screwed to the back of the controller. The contacts, the arcing tips on the main contacts and the fingers are easily removed and renewed.

Another important particular which assures the adaptability of these controllers to various conditions is the fact that the handle and ratchet are so designed that they may be removed from the controller and placed at any point which is convenient, and which permits connection to the controller by means of bevel gears and shafting. This not only adapts the apparatus for distant control, but it enables the operator to use the identical handle, ratchet and indicator dial which are furnished with the controller. This not only saves the expense of making a new handle and ratchet, as is necessary with other appliances, but retains the advantages of the peculiarities of the Westinghouse operating mechanism.

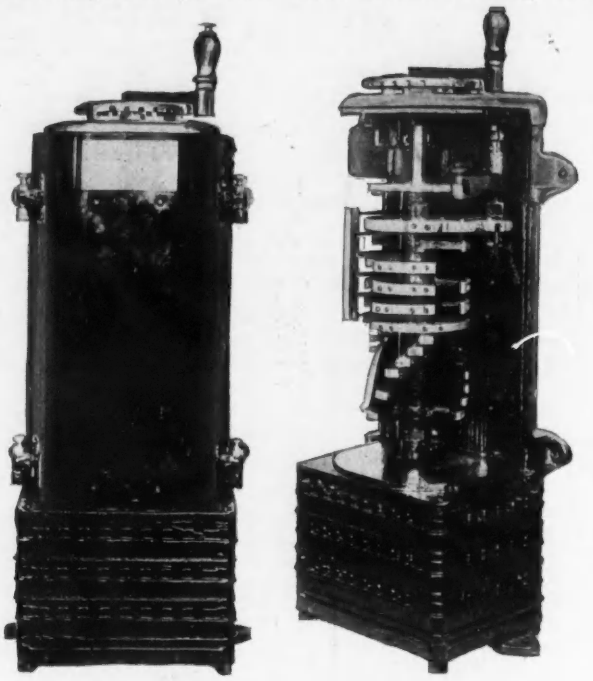


FIG. 2.—CONTROLLER FOR THREE-WIRE, TWO-VOLTAGE CIRCUITS.

The notches in the ratchet are positive, and the design is such that as each step is reached a key drops into a notch and stops the handle, holding it firmly in place until released by a pressure upon the thumb stop in the end of the handle. The operator is thus able to watch his work uninterruptedly while applying power or changing the speed, a fact of distinct advantage.

In the type V controller the starting resistance is inserted when the first contact is made, being cut out when the handle is moved to the second position.

In the type W, a cam lifts from the contact the finger, whose function is to cut out the starting resistance, and thus leaves the resistance in circuit when starting or when changing to a higher or a lower voltage. By means of a dash-pot, the return of the finger is delayed for a predetermined interval of time, the speed of the return being regulated by means of a screw. The checking medium is a non-freezing liquid, greatly superior to air as a means of even and close regulation and not affected by atmospheric conditions. If desired, the dash-pot can be removed without disturbing any other portions of the controller.

Arc shields are placed between all contacts which carry the main current, and in addition all sizes above 10 hp have a powerful magnetic blow-out coil. In capacities to and including 10 hp, the resistance, which is of the imbedded type, is regularly mounted directly beneath the controller. In large sizes it is mounted separately. The leads are conveniently located and have screw connectors.

In every particular these controllers have been designed to give superior service under even the least favorable conditions. They have an unusual amount of strength and durability, and the large assortment insures the adoption of the proper controller to give the best results in every instance.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The stock market was dull and narrow, trading being entirely professional. The uncertainty as regards the Northern Securities complications is still a factor in the market. The reports of slackness in the iron trade caused weakness in United States Steel preferred. Easy conditions prevailed in the money market, and the demand for time loans was light, plenty of money being obtainable at 4 per cent. Commercial paper was in demand at 4½ per cent., but the supply was only moderate. Toward the end of the week there was a better tone in the stock market. Some strength was exhibited in traction, gas and other specialties. Metropolitan Street Railway was favorably influenced by the prospect of its bidding on some of the new subway work proposed by the New York Rapid Transit Commission. The prices ranged from 110½ to 114⅝, closing at 114⅞—a net gain of ⅜. Fifty-one thousand, nine hundred and eighty shares of this stock were traded in. Brooklyn Rapid Transit was quiet in respect to trading, but it was firmer and closed with a net gain of 1¼ points, the last price being 47½, which was also the highest of the week. General Electric closed at the highest quotation, 164½, and Westinghouse at 158, which represents a net decline of 3 points. Allis-Chalmers common closed at 6½ which was also the lowest point for the week and a net loss of 1⅜, while the preferred closed at 43, the highest figure. The closing quotations and net changes in other stocks in the electric class were: American Telegraph and Cable, 86, a loss of ¾; American Telephone and Telegraph, 126¾, gain ¾; Commercial Cable, 187, loss 2, and Western Union, 88⅞. The curb market showed some activity and firmness, but was irregular. The main interest centred in the newer stocks, Mackey Company shares being freely dealt in. The common showed noteworthy strength, while the preferred reacted several points on what looked like profit-taking sales. Mackey common closed at 24, being a net gain of 4 points, but the preferred lost 3⅞, closing at 134½. The closing prices of the main market, of April 26, are as follows:

NEW YORK.

	Apl. 19	Apl 26		Apl. 19	Apl. 26
Allis-Chalmers Co.	6¾	6½	Electric Vehicle	5¾	5
Allis-Chalmers Co. pfd.	40	39	Electric Vehicle pfd.	9	8
American Tel. & Cable	85	86	General Electric	163½	161
American Tel. & Tel.	126	126	Hudson River Tel.	..	..
American Dist. Tel	23	23	Metropolitan St. Ry.	111¼	113
Brooklyn Rapid Transit	44¾	46⅛	N. Y. & N. J. Tel.	..	..
Commercial Cable	170	185	Marconi Tel.	..	..
Electric Boat	24	25	Western Union Tel.	88¾	88⅝
Electric Boat pfd	57	61	Westinghouse com.	159	158
Electric Lead Reduction	⅛	⅛	Westinghouse pfd.	175	175

BOSTON.

	Apl. 19	Apl. 26		Apl. 19	Apl. 26
American Tel. & Tel	..	126	Western Tel. & Tel. pfd.	..	*80
Cumberland Telephone	..	113	Mexican Telephone	..	1¼
Edison Elec. Illum.	..	238	New England Telephone	..	*123
General Electric	..	180¼	Mass. Elec. Ry.	..	20
Western Tel. & Tel.	..	..	Mass. Elec. Ry. pfd.	..	73

PHILADELPHIA.

	Apl. 19	Apl. 26		Apl 19	Apl. 26
American Railways	44	44	Phila. Traction	95⅛	..
Elec. Storage Battery	57	57	Phila. Electric	5⅜	5⅜
Elec. Storage Battery pfd.	57	57	Phila. Rapid Trans.	13⅜	13½
Elec. Co. of America	8	7¾			

CHICAGO

	Apl. 19	Apl. 6		Apl. 19	Apl. 2
Central Union Tel.	..	..	National Carbon pfd.	100	102½
Chicago Edison	..	..	Metropolitan Elev. com.	15	15
Chicago City Ry	155	155	Union Traction	5¾	5½
Chicago Tel. Co.	115	..	Union Traction pfd.	30¼	30¼
National Carbon	28	28			

*Asked

TROLLEY AND STEAM.—The statistics of street railways are compared by the *Wall Street Journal,* with the statistics of the steam roads in the United States for the same year. Already the mileage of the electric street railways amounts to 11 per cent. of the steam mileage. The capital stock amounts to 21 per cent.; the funded debt to 13 per cent.; the dividends to 18; and the interest on bonds to 14 per cent. When one remembers that electric street railways are a development of a very few years, and the steam railroads of the United States are a development of three-quarters of a century, this showing seems little less than marvellous. It appears, however, that the total capitalization of stocks and bonds of the street railways amounts to $96,287 per mile, while the total stock, bonds and unfunded debt of the steam railroads amounts to $64,371 per mile. The dividends paid by the electric street railways amounted to 2.5 per cent. of the total outstanding stock, while the dividends paid by the steam railroads amounted to 2.9 per cent., the comparison being for 1902. From this it would appear that the steam railroads are on a better basis, as regards earning power, than the street railways. The latter, however, are essentially passenger traffic lines. In 1902 they carried nine times as many passengers as all the steam railroads of the United States. These, while carrying over 655,000,000 of passengers, nevertheless obtained the bulk of their revenue from the carriage of freight.

CHICAGO EDISON REPORT for the year ended March 31, 1904, is as follows:

	1904.	1903.	1902.	1901.
Gross	$3,837,659	$3,409,576	$2,806,609	$2,517,219
Expenses	2,515,050	2,195,647	1,720,820	1,614,260
Net	$1,322,619	$1,213,929	$1,085,789	$902,959
Charges	307,088	300,900	300,983	279,791
Surplus	$1,015,531	$912,939	$784,806	$623,168
Dividends	720,526	593,346	515,982	477,688
Surplus	$295,005	$319,593	$268,824	$145,480

The general balance sheet as of March 31, 1904, compares as follows:

Assets:	1904.	1903.	1902.
Plants, etc.	$16,940,220	$14,230,840	$12,766,540
Material	326,498	388,025	405,494
Accounts receivable	656,998	784,465	358,997
Cash	262,933	136,035	121,033
Total	$18,186,650	$15,539,365	$13,652,064
Liabilities:			
Capital stock	$9,865,880	$7,589,500	$6,899,900
Advance payment for stock	.....	997,357	.....
Bonds and debts	6,483,000	5,508,000	5,508,000
Accounts payable	250,130	123,859	140,336
Depreciation reserve	690,000	590,000	500,000
Insurance fund	76,000	68,000	6,000
Surplus account	797,088	610,084	431,077
Open accounts	24,551	52,565	112,751
Total	$18,186,650	$15,539,365	$13,652,064

The allied Commonwealth Electric Company makes the following report:

	1904.	1903	1902.	1901.
Gross	$1,350,999	$1,002,085	$769,666	$629,047
Expenses	834,734	623,264	497,903	410,176
Net	$516,265	$378,821	$271,763	$218,871
Charges	275,737	220,704	167,261	137,770
Surplus	$240,528	$158,117	$104,502	$81,101

The Chicago Edison Company earned 10.2 per cent. on the present outstanding capital, and has declared the regular 2 per cent quarterly dividend payable May 1st. Its gross business increased 12.5 per cent. for the year. The Commonwealth Electric Co. is at present a subsidiary corporation, owning the outlying plants, but in 1911 it will become the successor of the Edison Co. It is now building what will be the largest central station plant in the country, and its business increased 34.8 per cent. last year. The earnings amounted to 3.84 per cent. on the present outstanding capital. In the balance sheet of the Commonwealth Electric appears an item of $32,033 credited to "municipal compensation reserve." The company's ordinance provides that the company shall begin the payment of compensation to the city at the rate of 3 per cent. per annum of the gross receipts after the first five years of the life of the franchise. Compensation began to accrue on June 30 of last year.

DIVIDENDS.—Directors of American Light and Traction Company have declared the regular quarterly 1½ per cent. dividend on the preferred stock, payable May 2. A dividend of 40c. per share has been declared upon certificates of deposit of the Edison Electric Illuminating Company, of Brooklyn, payable May 5. Automatic Electric Company's directors have declared the regular quarterly dividend of 2 per cent. payable May 2. This is the old Strowger Automatic Telephone, which has grown into a big business. American Graphophone directors have declared a dividend of 1 per cent. on the common stock, payable June 15. The Cincinnati Gas & Electric Company has increased the dividend ½ per cent. to 4½ per cent. per annum.

FINANCING LONDON UNDERGROUND.—Speyer & Co. and Blair & Co. offer $10,000,000 5 per cent. profit-sharing secured notes, due June 1, 1908, of the Underground Electric Railways Company, of London, England. The notes are offered at 96½ and interest. This is part of an issue of £7,000,000 sterling, of which $16,650,000 are payable in United States gold. The proceeds of this issue of notes are being used for the construction and equipment of the railways of the Tube Companies, and for electrically equipping the existing lines of the Metropolitan District. The Underground Co. has a capital of £5,000,000 fully subscribed (£2,500,000 paid up). The articles of association provide that Messrs. Speyer & Co., of New York; the Old

Colony Trust Company, of Boston, and Speyer Brothers, of London, shall, during a period of ten years, have the right to nominate a majority of the directors for the time being of the company, thus insuring a continuity of management. Mr. Yerkes says: "There is every probability that all the tube lines will be finished in about two and a half years from the present time. The fact that the power station will be entirely completed leaves us with only the construction of the two lines, and the building of the stations, which can always be pushed along with rapidity. I am happy to say that our expenditures are well within our estimates, which is a condition not often realized."

WASHINGTON, D. C., REPORTS.—The Washington (D. C.) Railway and Electric Company reports as follows for the year ended December 31, 1903:

	1903.	1902.	1901.
Gross	$1,400,441	$2,325,755	$2,162,559
Expenses	561,271	1,251,814	1,187,449
Net	$839,170	$1,073,961	$975,110
Other income	.....	19,644	16,016
Total income	$839,170	$1,093,605	$991,126
Charges	617,291	892,477	892,477
Surplus	$221,879	$201,128	$98,649

GENERAL ELECTRIC ANNUAL MEETING.—The annual meeting of the stockholders of the General Electric Company will be held at the company's office in Schenectady, N. Y., on May 10, 1904, for the election of directors for the ensuing year.

Commercial Intelligence.

THE WEEK IN TRADE.—The cold weather complaint is still with us. It is interfering with planting preparations and growth, and interrupts outdoor activity in many lines, notably building. Spring trade on the whole is very quiet and collections are slow, although a slight improvement is noted in the latter as compared with previous weeks. All weather and crop reports show the influence of the cold upon plant preparation and growth. In the iron and steel industry the quiet of the previous week has been more pronounced. The demand for deliveries during the second quarter of the year is insistent, but there is an evident hesitation in placing orders for finished products for the remainder of the year. Manufacturers of agricultural implements are the freest buyers. The Pacific Coast lumber trade is still unsatisfactory, but there is report of improvement in general trade. In the eastern markets retail and jobbing trade is rather quiet. There was an increase in business failures during the week ending April 21, as compared with those of the corresponding week last year, the figures for the two periods being 199 and 152 respectively. Copper was dull and featureless, the closing quotations being 13 at 13¼c. for Lake; 12⅞ at 13c. for electrolytic, and 12½ at 12¾c. for casting stock. Activity is noted in the rubber trade.

BIG AUSTRALIAN LIGHTING AND POWER SCHEME.—Australian advices state that an electric light and traction offer has been made to the Victorian Government through the representative of a local company now in London. The gentleman in question, T. Holroyd, manager of the Victorian Light and Power Distributing Corporation, has, according to cabled reports, associated with his company five leading electrical engineering firms in Great Britain, one of which concerns is understood to be the British Westinghouse Electric and Manufacturing Company, Limited. This syndicate has cabled an offer to the Victorian Government to supply the Government and City Councils with electric current at 1d.—two cents—per unit provided not less than 10,000,000 units are consumed annually for at least 10 years. The syndicate intends to generate current from the large coal deposits known to exist between Laverton and Werribee, some seven miles distant from Melbourne. These deposits were tested by Mr. Holroyd's company, who hold options on over 10,000 acres of land. Their proposal is to erect in the vicinity of Laverton, a plant whence the power could be distributed and the consent of a number of municipalities was obtained by the company some time ago. Half their capital being expended in the erection of boring plant, etc., and a large sum being required to carry out the proposals in their entirety, Mr. Holroyd went to London to float a larger company, and the outcome of his visit is the offer before stated. Under their programme, as put forward some time ago, the Victorian members of the syndicate undertook to supply power to private consumers at not more than 8 cents per unit for lighting and not more than 4 cents per unit for power purposes.

THE HENRY R. WORTHINGTON HYDRAULIC WORKS, at the corner of Rapelyea and Van Brunt Streets, Brooklyn, are shortly to be removed to Harrison, N. J., to occupy the new $2,000,000 plant of the International Steam Pump Company, now nearly completed. The Brooklyn site consists of two city blocks, or about four and one-half acres, while the Harrison plant is located on a 35-acre tract and contains 18 acres of floor space. The Worthington Company is one of the oldest and largest manufacturing concerns of Brooklyn, having been founded in 1843 by Henry R. Worthington, the inventor of the duplex steam pump and other hydraulic devices. About 2,000 men are employed in the South Brooklyn works and the new plant at Harrison will accommodate from 5,000 to 6,000 men. The Brooklyn works will probably be sold, the company having already disposed of its large foundries at Elizabethport, N. J. The new plant will employ electric power on a large scale.

NEW ORLEANS LIGHTING FRANCHISE.—A 10-year franchise to date from September 30, 1905, for lighting the public highways, street, squares and parts of the city of New Orleans with electricity and for furnishing electric energy for public buildings for the operation of arc and incandescent lights, motors, pumps, fans, elevators and other public purposes, has been granted by the municipal authorities of the Crescent City to the New Orleans Railway Company, for which concern Sanderson & Porter, Kuhn-Loeb Building, William Street, New York, act as consulting engineers. The franchise calls for the lighting of 476 underground district circuits at $83, and for 2,151 overhead district circuits at $69. It also includes 200,000 kw of power at six cents per kilowatt hour. The company will receive $200,879 per annum for the service.

TELEPHONE EQUIPMENT WANTED.—Mr. M. A. Joy, cotton compress owner, etc., at Camden, Ark., is the proprietor of the Ouachita Telephone Company. It is to be entirely reconstructed, with a central energy equipment of from 300 to 500 central energy visual signal lines, 20 magneto jacks and drops for toll lines, and 300 telephone sets. The construction will include complete new material inside and out, with some 10,000 ft. of cable 25 to 200 pair. The exchange has been in operation for some years and will now be brought up to date. Mr. Joy is in the market to make immediate purchase of this equipment.

MERGER OF SIGNAL COMPANIES.—A negotiation whereby the Taylor Signal Company, of Buffalo, N. Y., and the Pneumatic Signal Company, of Rochester, are to to be merged into one firm, to be known as the General Railway Signal Company, has just been completed. It is capitalized at $5,000,000. Although the officers of the General Railway Signal Company have not been selected, it is said to be settled that W. W. Salmon, of the Taylor Signal Company, will be the executive head of the firm.

MAGNET WIRE COMPANY'S ORDERS.—The Magnet Wire Company, 42 Broadway, has secured a substantial contract from the Massachusetts Electric Companies for magnet, trolley and weather-proof wire. The Pittsburg (Pa.) Coal Company has sent in a fair-sized order for trolley wire. The Cleveland Electric Railway Company has also requisitioned for a fair-sized lot of trolley wire and for magnet and weather-proof. The Interborough Rapid Transit Company has also sent in a good-sized order for specialties.

EQUIPMENT FOR TROY, N. Y., HOTEL.—MacKenzie, Quarrier & Ferguson, New York, have been awarded the contract for the electrical equipment of a large new hotel to be built at Troy, N. Y. and to be known as the Rensselaer. There will be two 75-hp Harrisburg standard engines direct connected to 50 kw generators of General Electric build. The switchboard will be made by the Walker Electric Company, of Philadelphia. The equipment will be used for both lighting and power purposes.

EQUIPMENT FOR CANADIAN SINGER PLANT.—Considerable electrical equipment will be installed in the Canadian plant which is to be built by the Singer Manufacturing Company, of Elizabethport, N. J. The machinery will include a 600-kw generating set and some 200 hp of motors ranging from 1 hp to 5 hp each.

HEINE BOILER ORDER.—The Electric Company of America, Philadelphia, which controls the Auburn, N. Y., Light, Heat and Power Company, has awarded an order to the Heine Safety Boiler Company, New York, offices, Bowling Green Building, for additional boiler equipment for the Auburn plant.

NUEVO LEON WATER POWER SCHEME.—Francisco Garza Trevino, of Monterey, Mexico, has been granted a concession by the government authorities with a view to the construction of a large water power plant on the Rio Ramos, Cadereita district, State of Nuevo Leon. The current will be used for general power purposes.

LIGHTING EQUIPMENT FOR CUBAN PLANTATION.—The Robb Engineering Company, of Amherst, Nova Scotia, represented by G. F. Tremain, 136 Liberty Street, has taken a contract for a 300-hp automatic Robb-Armstrong engine for direct connection to a Stanley generator for lighting a large Cuban sugar plantation.

EQUIPMENT FOR $1,000,000 APARTMENT HOTEL.—Percival Robert Moses, the consulting engineer, 35 Nassau Street, is drawing up plans for the electrical equipment to be installed in a $1,000,000 apartment hotel at 10-14 East Twenty-eighth Street, for C. F. Rogers.

BELL TELEPHONE OUTPUT.—The American Telephone and Telegraph Company instrument statement for the month ended March 31, is as follows:

	1904.	1903.	1902.	1901.
Gross output	126,522	84,286	96,557	76,751
Returned	35,043	38,172	42,847	37,517
Net output	91,479	46,108	53,710	39,234
Total outstanding	3,972,095	3,339,635	2,691,065	2,079,498

The statement for January, 1903, showed a gross output of 129,837, and a net output of 86,551; but this statement covered 42 days, from December 20, 1902, to January 31, 1903. It was in this month that the company changed its system of reporting instrument output so as to cover the calendar months. The net output since the close of the fiscal year December 31, 1903, was 192,578, making total instruments outstanding March 31, 1904, 3,972,095. The indicated gain in the number of subscribers is about 75,000, making the total number of subscribers March 31 in excess of 1,600,000. The indicated gain in the gross earning capacity of the Bell system, at $50 per subscriber, is $3,750,000 per annum; and the indicated gain in net earning capacity is over $1,000,000 per annum. With the number of subscribers now at 1,600,000, the annual gross earnings of the Bell Telephone system will amount to $80,000,000, of which about $23,000,000 is estimated as net earnings.

DE LAVAL TURBINES, ETC., FOR WESTERN PLANTS.—The Turbine Engineering Company, Whitehall Building, Battery Place, New York, recently organized for the purpose of assuming contracts covering the installation of power units and carrying on a general engineering business in addition to acting as exclusive selling agents for the De Laval turbines in Illinois, Missouri, Michigan, Iowa and Indiana, has secured a contract for two De Laval turbine dynamo sets of 200 kw capacity each, direct current, 240 volts, to run condensing, for lighting purposes in the plant of the Anheuser-Busch Brewing Association, at St. Louis. The order has also been taken from the Pfister & Vogel Leather Company, of Milwaukee, for a De Laval turbine dynamo set—the second order—direct current, 250 volts, to run condensing. A 35-kw direct-current turbine dynamo set is also to be put in the Gund Brewing Company's plant at Cleveland, Ohio. A De Laval steam turbine centrifugal pump of 300-hp capacity 4,750,000 gallons per day, to operate against a head of 230 feet, is to be installed at the Ottumwa, Iowa, water works.

MACKAY ENGINEERING COMPANY ORDERS.—The MacKay Engineering Company, Singer Building, New York, has secured a contract for a 40-hp two-cylinder Walrath gas engine to be manufactured by the Marinette Gas Engine Company, of Chicago Heights, Ill., for direct connection to a General Electric generator. This outfit will be used for lighting Calumet Island, St. Lawrence River, Clayton, N. Y. The M. F. Thompson Dry Good Store, at Binghamton, N. Y., is also to be equipped for lighting purposes with a 30-hp, two-cylinder Walrath gas engine. The new Rogers Building, at Fourteenth Street and Sixth Avenue, is to have a number of motors built by the Richmond, Va., Electric Company, for driving centrifugal pumps, MacKay blowers, etc. The Fraser Tablet Company, Eighteenth Street and Eighth Avenue, Brooklyn, has requisitioned for several Richmond motors of 10 hp, 3 hp and 2 hp capacity, and the Wheeler & Wilson Manufacturing Company, 833 Broadway, New York, has ordered some small ones for operating sewing machines.

MILK BY TROLLEY.—Besides handling ashes and building material, and the contract entered into with the Bush Terminal Company for the handling of package freight as already described and illustrated in these pages, Brooklyn Rapid Transit Company has recently entered into arrangements with Borden's Milk Company whereby it will haul this company's milk supply to the distributing stations. It is now hauling beer in the Coney Island section. The Borden Company has taken its milk from the cars in Jersey City by its own teams to its depots in Brooklyn, but hereafter the railroad cars will be floated over to South Seventh Street, and the cans there transferred to the trolleys of the Brooklyn Rapid Transit. Not only will this mean a saving for the milk company and increased earnings for the trolley company, but the milk itself will reach the consumer in better condition. The delivery of beer by trolley in the Coney Island section is giving satisfaction.

WATERTOWN ENGINE ORDERS.—Recent orders for Watertown engines include the following: One 12 & 20 x 14 tandem compound engine for Jacob Ruppert, New York City; two 15½ x 14 high speed engines arranged for direct connection to Sprague generators, for Christian Feiganspan, Newark, N. J.; two 13 x 12 high-speed engines arranged for direct connection to Crocker-Wheeler generators, for Ballantine & Co., Newark, N. J.; two 17 x 16 four-valve engines for F. Wesel Manufacturing Company, Brooklyn, N. Y.; one 17 x 16 four-valve engine, Bloomingdale Bros., Fifty-ninth Street, New York; one 17 x 18 four-valve engine, Railway Steel Spring Company, Oswego, N. Y., this being the fourth order from this concern; one 17 x 18 four-valve engine, Bernardsville Electric Light Plant, Bernardsville, N. J.

THE STERLING ELECTRIC COMPANY, Lafayette, Ind., reports an unusual activity in switchboard work, having contracted for switchboards and additional equipment during the past month for Kansas, Ill.; Newton, Ill.; Hudson, N. Y.; Racine, Wis.; Sheboygan, Wis.; Peru, Ind.; Auburn, Ind.; Russiaville, Ind.; Goldsmith, Ind.; Zionsville, Ind.; Seymour, Ind.; Cairo, Ill.; Clinton, Ill.; Decatur, Ill.; Abilene, Tex.; Albany, N. Y.; Canton, Ill.; Tremont, Ill.; Hoopeston, Ill.; McArthur, Ohio; Chardon, Neb.; Avery, Ind.; Brookville, Pa.; Austinburg, Ohio; Stackbridge, Mich.; Stranghn, Ind.; Sully, Iowa; Webster City, Iowa. The list includes equipments of its well-known boards of common battery multiple, lamp signal magneto, standard Bell type.

THE REEVES ENGINE COMPANY, Trenton, N. J., has just closed with the Drew-Selby Company, of Portsmouth, Ohio, for one of its 400-hp vertical cross compound engines for direct connection to an electric generator. Messrs. Plotner & Stoddard, of Dayton, Ohio, have also purchased a direct-connected 400-hp vertical cross compound. It has sold to the International Steam Pump Company four direct-connected vertical cross compounds. The Trenton Mills and Elevator Company has purchased one of its large vertical cross compounds and it has contracted with the Construction Realty Company to install three simple horizontal engines for direct connection to 65-kw generators, for its new hotel at Broadway and Sixty-ninth Street, New York.

LIGHTING EQUIPMENT FOR TIENTSIN.—Contracts are expected to be let in this market shortly for various equipment to be installed at Tientsin, for the purpose of lighting the British settlement in that Chinese city. The plant will have a capacity of 300 hp. There will be two 100-kw generators direct connected to 13-in. x 14-in. engines. The boilers will be of water-tube type—two units. The street lighting will be done by 250 arc lamps. The export commission house of Muller, Maclean & Co., Centennial Building, 116 Broad Street, whose treasurer, L. E. Phipps, has just returned from the Far East, holds a copy of the specifications, etc.

PHONOGRAPH WORKS BURNED.—The interior of the large four-story building of the Victor Talking Machine Company, at Camden, N. J., was totally destroyed by fire on April 24, causing a loss estimated by an official of the company at nearly $500,000. The concern carried an insurance of $250,000. Upward of 50,000 phonographic disk records and 25,000 talking machines in various stages of completion were destroyed. Thousands of original records, which cannot be replaced, were also ruined. A fireboat and four fire companies from Philadelphia assisted the Camden Fire Department in preventing the flames from spreading.

JALISCO WATER POWER PROJECT.—A fair-sized hydraulic plant is to be built on the Rio Grande de Santiago, municipality of Hostotitaquillo, State of Jalisco, Mexico. Francisco Brenna, of Mexico City, has secured the necessary concession from the Secretary of Fomento. The franchise permits of the utilization of 15,000 liters of water per second. The power is to be generated principally for lighting towns in the vicinity.

EQUIPMENT FOR APARTMENT HOTEL.—The apartment hotel which is being constructed at Sixty-ninth Street and Broadway, is to be equipped for lighting purposes with three 13-in x 12-in. simple engines of Reeves build direct connected to 65-kw C. & C. generators. Percival Robert Moses, 35 Nassau Street, is the consulting engineer.

WESTINGHOUSE EQUIPMENT FOR CANTON PLOW PLANT.—The contract for the additional equipment—500 hp—to be installed in the big agricultural implement manufacturing plant of the Parlin & Orendorff, at Canton, Ohio, has been allotted to the Westinghouse Company.

MONTAUK FIRE DETECTING SYSTEM FOR AUSTRALIA.—The Montauk Fire Detecting Wire Company, American Surety Building, New York, has just received a large Australian contract by cable for its specialties to be installed in one of the principal Melbourne theatres.

EQUIPMENT FOR MEXICAN MINES.—An American syndicate in which William M. McCord and Lucien M. Fairbanks, of Chicago, Ill., are largely concerned, is about to erect a large electrically operated mill at the Peregrino mines in the Guanajuato district, Mexico.

GENERAL ELECTRIC DESK FANS FOR EGYPT.—The General Electric Company has secured a substantial contract for desk fans for export to Alexandria, Egypt. The order was secured through the export commission house of Muller, Maclean & Co.

General News.

THE TELEPHONE.

TRINIDAD, COL.—The Colorado Telephone Company has moved into its recently completed new building, and the overhead wires have been placed under ground. The equipment of the new building is of the most modern design. About $100,000 was expended by the company in these improvements.

PEARL CITY, ILL.—The Farmers' Mutual Telephone Company has been organized here with L. C. Hollister as president.

CAMPUS, ILL.—The Campus Telephone Company has been incorporated with a capital stock of $2500. A. J. Harrington is one of the directors.

ASSUMPTION, ILL.—A new telephone company has been formed here. Among those interested are Ray Johnson, Dennis Keating and others.

DUVAL, ILL.—The Okawa Township Telephone Company has been incorporated with a capital stock of $2500 by William Hendricks, G. L. McCullough and Alex Roberts.

NEW HOLLAND, ILL.—The New Holland Telephone Company has been incorporated with a capital stock of $2,500. The directors are J. W. Collins, P. E. Kuhl and L. C. Schwerdtfeger.

SUMMITVILLE, IND.—The Farmers' Rural Telephone Company has been incorporated with a capital stock of $5000. F. P. Thurston, G. W. Webster and others are the incorporators.

RANDALL, IA.—The Martin Telephone Company will install a new switchboard here.

STORY CITY, IA.—The Gilbert and Story City Telephone Company has been formed to build a rural line.

PLYMOUTH, IA.—The Plymouth Telephone Company has been incorporated with a capital stock of $10,000.

OXFORD, IA.—The Eastern Iowa Telephone Company has been incorporated with a capital stock of $100,000.

FOREST CITY, IA.—The Farmers' Co-operative Telephone Company has been organized with G. A. Faber as president.

CHASE, KAN.—The Chase Telephone Company has been incorporated with a capital stock of $5000.

ENGLEVALE, KAN.—The Englevale Telephone Company has been incorporated with a capital stock of $5000.

FRANKFORT, KY.—The Allen County Home Telephone Company has been incorporated with a capital stock of $2500. A. M. Haines and S. F. Cornwell, of Hainesville, are the incorporators.

NORTH ATTLEBORO, MASS.—A new telephone building is to be erected here for the Providence Telephone Company.

COLDWATER, MICH.—The Wolverine Telephone Company has been organized here.

SOUTH HAVEN, MICH.—The Kibbie Telephone Company will build a line from South Haven to Covert.

EAST AMBOY, MICH.—The Dutch Street Telephone Company has been incorporated. J. B. Dick is president.

HINKLEY, MINN.—The Hinkley & Rural Telephone Company has been formed to build lines in this vicinity.

AUSTIN, MINN.—The Tri-State Telephone Company will build a long-distance line from this place to Lacrosse, Wis.

ANOKA, MINN.—The Potato Belt Telephone Company has been incorporated with a capital stock of $20,000. R. J. Dyer is president.

HATTIESBURG, MISS.—The Cumberland Telephone Company has petitioned for a franchise in this place, but there is considerable opposition to granting the same. There is a local system in operation which is controlled by local capitalists. The latter are willing, however, that the council grant the Cumberland company the privilege of establishing a long distance station here.

BIG TIMBER, MONT.—A co-operative telephone company has been organized here to construct a telephone line between Big Timber and Melville, a distance of 45 miles. B. O. Felland is president; E. H. Ellingson, secretary, and D. O. Clack, treasurer.

CHARLESTON, MO.—The Southeast Missouri Telephone Company has been incorporated with a capital stock of $150,000. The directors are M. Moore, J. E. Armstrong and others.

MOBERLY, MO.—The Cairo Telephone Company has elected officers as follows: President, Harry McKinney; vice-president, F. Haines; secretary, John Boucher; treasurer, J. W. Stigall.

ST. LOUIS, MO.—The Kinloch Telephone Company will install in the Palace of Electricity at the Exposition a "model" telephone exchange. The switchboard is for 1000 lines, and instruments will be placed in all of the World's Fair buildings and in all parts of the grounds.

CHARLESTON, MO.—The Southeast Missouri Telephone Company has been incorporated to establish and operate telephone exchanges at Charleston, Sikeston, Dexter, Melden, Campbell and Bloomfield. The capital stock is $150,000. The incorporators are J. Handy Moore, Paul B. Moore, Mary Moore, J. E. Armstrong and R. B. Boyce.

LINCOLN, NEB.—The Dewitt Telephone Company has increased its capital stock to $20,000.

EGG HARBOR CITY, N. J.—The Egg Harbor Telephone Company has been organized with a capital stock of $3000 by L. Krevin, W. G. Shottman, G. W. Otto and Charles Oberuder.

PENNINGTON, N. J.—The Pennington Telephone Company has been incorporated with a capital stock of $5000. The incorporators are: William H. Bogart, Jerry F. Crowerly and Joseph F. Harris.

NEWARK, N. J.—The Newark Telephone Exchange has been incorporated with a capital stock of $25,000. The new company has purchased the local telephone system established and operated by Mr. William H. Kelley. The exchange has 220 telephones. The directors of the new company are: William H. Kelley, John E. Pulver, Ernest A. Smith, Edward P. Thatcher, J. P. Ballou, F. D. Burgess and Albert Proseus.

WOLCOTT, N. Y.—A new telephone company is being organized here with E. T. Phillips as president.

COOPERSTOWN, N. Y.—The Cooperstown Telephone Company has increased its capital stock from $7,000 to $10,000.

CORTLAND, N. Y.—The Empire State Telephone Company has asked permission of the council of this place to place its wires in underground conduits.

DUNDEE, N. Y.—The Dundee, Himrod & Dresden Telephone Company is being organized here to build a line from this place to Himrod and Dresden. Mr. Henry C. Harbending, of Dundee, is interested.

SARATOGA, N. Y.—The Commercial Union Telephone Company has arranged to purchase the property and rights of the Saratoga Telephone and Telegraph Company, the Rensselaer Telephone and Telegraph Company, of Troy, and the Union Telephone Company, of Glens Falls. Each of the individual companies has voted in favor of the consolidation.

FAIRMOUNT, N. D.—The Farmers' Telephone Company will be incorporated with a capital stock of $6000.

STRUBLE, OHIO.—The LaMars Telephone Company has been granted a franchise.

SPRINGFIELD, OHIO.—Prominent citizens are organizing an association favoring the use of one telephone system. They think that two are a nuisance.

CENTERBURG, OHIO.—The Central Ohio Telephone Company has been incorporated with a capital stock of $10,000. The directors are: T. P. Sylvan, E. E. McGuire and others.

COLUMBUS, OHIO.—The Preble County Telephone Company has been incorporated with a capital stock of $25,000. The incorporators are: John C. Stover, J. E. Flora, A. M. Fudge and J. S. Steward.

EAST LIVERPOOL, OHIO.—The Winona Central Telephone Company has commenced the construction of an exchange in Dungannon. It will take care of 40 or 50 telephones to begin with. The company will build another trunk toll line to Lisbon.

CLEVELAND, OHIO.—President Dickson, of the United States Telephone Company states that he has secured $150,000 of new money for use in the development and extension of the long distance lines of the company. The money will be used in connecting the United States system with those of the Indianapolis, St. Louis and Pittsburg independent systems.

CLEVELAND, OHIO.—President F. S. Dickson, of the Cuyahoga Telephone Company, states that since the new switchboard was installed two months ago the company has been gaining new subscribers at the rate of 15 per day. The company is now earning the dividend on its preferred stock and piling up a surplus that will be used for future improvements. President Dickson denies that the company will pay a dividend on common stock as reported in the daily press recently.

LINTLEYVILLE, PA.—A new telephone company has been organized here with A. N. Both as president.

PHOENIXVILLE, PA.—The Phoenixville Telephone Company has been organized here by E. C. Meier, William Ellis and others.

PHILADELPHIA, PA.—The Keystone Telephone Company's April directory is said to contain the names of some 14,500 subscribers, an increase of 1,500, more than 10% over the January directory. The number of nearby outside connections has also increased about 10%. The Atlantic City line of the company will open about May 15, making connection with the Atlantic Coast Telephone Company, a subsidiary of the Interstate Telephone Company, which has 1,600 subscribers in Atlantic City.

GRANITEVILLE, S. C.—A local telephone company has been organized here and will install the Clark automatic system. Arrangements have been made with the Southern Bell Telephone Company for long-distance connection. The new company has been incorporated with a capital stock of $3000, the officers being W. A. Giles, president and treasurer; Rev. Graves L. Knight, T. H. Rennie and W. A. Giles, board of directors.

NASHVILLE, TENN.—The Western Dixie Telephone Company, of Henry County, has been incorporated with a capital stock of $1,000. The directors are H. A. Liles, A. Turner and others.

SALT LAKE CITY, UTAH.—The management of the Rocky Mountain Bell Telephone Company announces that it will expend about $150,000 in the next few weeks in improvements to its system in Salt Lake.

OSHKOSH, WIS.—A. B. Ferdinand again seeks a franchise for an independent local telephone exchange.

EAU GALLE, WIS.—The Eau Galle Telephone Company has been incorporated with a capital stock of $5000. The directors are: C. G. Billings, Wm. Stoops and others.

MINERAL, WIS.—The Willow Springs Telephone Company has been incorporated with a capital stock of $4000. The directors are: J. P. Sheldon, R. M. Phillips and others.

ROBERTS, WIS.—The Roberts Telephone Company has been incorporated with a capital stock of $5000 by A. Turner, R. C. Andrus, George A. Turner, David Imrie and A. J. Walker.

SOUTH WAYNE, WIS.—The Crosby & Blaisdel Telephone Company, of South Wayne, Lafayette County, has been incorporated with a capital of $25,000. The incorporators are: A. N. Crosby, W. C. Blaisdel and W. R. Bixby.

ELECTRIC LIGHT AND POWER.

DEMOPOLIS, ALA.—The Demopolis Electric Light & Power Company contemplates an extension to its plant. A new brick engine room will be built. Mr. A. R. Smith, of Demopolis, is manager.

MALVERN, ARK.—The Malvern Light & Power Company contemplates the installation of a new dynamo and boiler. Mr. C. W. Turner, of Malvern, is president and manager.

PINE BLUFF, ARK.—The Pine Bluff Light & Water Company will install a new alternating current generator and direct-connected engine. Mr. Robert York, Pine Bluff, is manager.

VASALIA, CAL.—The Mt. Whitney Power Company is installing a second power plant containing three 500-kw units which are driven by Stilwell-Bierce and Smith-Vaile turbines. Mr. B. M. Maddox is manager.

WATSONVILLE, CAL.—The Big Creek Power Co. of Santa Cruz will purchase property in this city as a site for a plant to furnish the local circuit with electric power. About $100,000 will be spent in improving the service here.

LODI, CAL.—The Northern San Joaquin Electric Company has absorbed the Lodi Electric Works. The new company will give its patrons a continuous service. At the present time the lights are turned on at dusk and shut off at twelve o'clock.

LOS ANGELES, CAL.—The Los Angeles Gas Company and the Los Angeles Electric Company have been merged into a single corporation with a capital stock of $4,000,000. A meeting of the stockholders of the concerns is announced for April 27 to perfect the plans of consolidation.

MONTROSE, COL.—The Montrose Electric Light & Power Co. has secured a new site for an electric power, cold storage and ice plant to be constructed here this summer.

GLASTONBURY, CONN.—The Glastonbury Power Company has been incorporated in this State with an authorized capital stock of $350,000. The company proposes to develop the water power of Roaring Brook for electrical purposes. The project calls for an immediate development of 1,600-hp. The incorporators of the company are Lewis W. Ripley, Henry S. Goslee, D. W. Williams, James S. Williams, J. H. Hale and Frank D. Glazier.

WASHINGTON, D. C.—The Potomac Electric Power Company will, during the coming summer, put underground its 73,820 feet of overhead electric wires. The cost for this improvement is estimated at $16,000.

WASHINGTON, D. C.—Bids will be received May 3, at the Bureau of Supplies and Accounts, Navy Department, Washington, for furnishing at the navy yards, Portsmouth, N. H., Boston, Mass., and Newport, R. I., a quantity of arc lamps, switch boxes, conduit and fittings, copper wire, electrical supplies, crucible steel wire and other material. H. T. B. Harris, Paymaster Gen., U. S. N.

JACKSONVILLE, FLA.—Bids are wanted May 4 for furnishing f.o.b. cars at Jacksonville a 500-kw generator, together with exciter and switch panels; turbine to be worked condensing at 150 lbs. steam pressure; 27-in. vacuum; generator to be three phase, 60 cycle, 2,300 volts; makers must guarantee efficiency to be equal to first-class Corliss engine; also for surface condenser complete for above turbine, with separate water and dry vacuum pumps. For further information apply to R. N. Ellis, superintendent of water works and electric light plant.

ELGIN, ILL.—The Fox River Light, Heat & Power Company, of Elgin, Ill., it is stated, has purchased the Aurora, Elgin and Chicago Power Company from the Aurora, Elgin and Chicago Railway.

O'FALLON, ILL.—The O'Fallon Electric Light, Power, Heat & Water Company is changing its arc light system over to the alternating current system. Mr. G. W. Tidemann is president and superintendent.

NEVADA, ILL.—The Nevada Electric Company has let the contract for the extension of its power station. The electrical apparatus will be supplied by the Westinghouse Company and the engine by the Murray Iron Works, of Burlington.

QUINCY, ILL.—The Quincy Gas & Electric Company will extend its power plant in this city. A larger boiler, a new 2000-hp engine and a new General Electric generator will be installed. The improvements will cost $25,000. Mr. H. O. Channon is superintendent of the electric light plant.

NOBLESVILLE, IND.—The city council is asking for bids for a ten-years' contract to light the city.

NEW HARMONY, IND.—Bids are wanted May 16 for furnishing material and constructing an electric light plant.

FLORA, IND.—It is proposed to construct water works and an electric light plant, at a cost of $20,000. Address M. W. Eaton is president town board.

FT. WAYNE, IND.—The Ft. Wayne Electric Light & Power Company has completed its organization and will at once begin the reconstruction of its plant.

JASPER, IND.—The local electric light plant has been purchased by the town board for $7,000. The town will make extensive improvements and betterments.

BOONVILLE, IND.—The City Light & Power Company has been incorporated with a capital stock of $12,000, by J. F. Katterjohn, John E. Madden, Dorsey Reed, Louis J. Meyer and William Roth.

NEWBURY, IND.—The Newbury Electric Light & Power plant will install some new apparatus during this year, including a generator, engine and boiler. A water works system will also be introduced. Mr. G. F. Lacke is the owner.

ROANOKE, IND.—The town council has made arrangement with the Ft. Wayne and South Western Traction Company for electric lighting for the streets and business houses. The company will move a sub-station now a mile east of Roanoke to the city and will build another sub-station.

ARDMORE, IND. TER.—The Ardmore Ice, Light & Power Co., of Ardmore, has been incorporated with a capital of $125,000, by A. Ruemmeli, of St. Louis, Mo.; Henry Brann and L. P. Anderson, of Ardmore, and others.

WINFIELD, KAN.—The citizens have voted to issue $30,000 bonds for electric lighting.

GREAT BEND, KAN.—The Grimes Light, Telephone & Power Company will install another alternator before next fall.

BALTIMORE, MD.—A strong fight is being made in the city council for and against the petition of the Maryland Telephone Company for an electric light franchise. Mayor McLane a few days ago received a petition 24 yards long and containing over 1,500 signatures of corporations, firms and individuals who asked that the ordinance be passed. The ordinance has already passed the second branch of the city council and is now before the first branch for consideration.

WESTFIELD, MASS.—An appropriation of $10,500 has been voted by this town for a new electric power plant, and $1,000 for motors for use in heating and ventilating school buildings.

EATON RAPIDS, MICH.—The citizens have voted to issue water and lighting bonds.

KALAMAZOO, MICH.—The Kalamazoo Valley Electric Co. will soon begin the construction of a power plant at Ceresco on Kalamazoo River, at an estimated cost of $200,000.

ALLEGAN, MICH.—The Allegan Light & Power Company's plant has been sold to Messrs. S. Baker, H. A. Delano, George E. Delano, of Otsego, and F. M. Van Auken of Allegan. The change will take effect on May 1. The price paid is understood to be about $15,000. It is stated that the Kalamazoo Valley Electric Company will ask for a franchise to do commercial and domestic lighting in this city.

FARIBAULT, MINN.—The Faribault Gas & Electric Co. contemplates the installation of improvements at its manufacturing plant, and engineers are now figuring on the best methods of installation, probable cost, etc. Among the many improvements under consideration is the installation of a steam turbine.

CHARLESTON, MO.—The Southwest Missouri Ice, Light & Power Co. has been incorporated with a capital of $100,000. J. E. Armstrong and R. B. Boyce, of Charleston, are among the incorporators.

ROSWELL, N. M.—A franchise has been granted to Maynard Gunsul to furnish electricity for power, heat and illuminating purposes in this city.

CORTLAND, N. Y.—It is stated that the Cortland & Homer Electric Co. is to improve and enlarge its plant.

SAG HARBOR, L. I., N. Y.—Bids will be received by the Village Trustees until May 3 for $24,000 electric light bonds.

GOUVERNEUR, N. Y.—The Village Trustees have granted J. Henry Abbott a franchise for an electric light plant.

MANLIUS, N. Y.—The Manlius Gas & Electric Co. has been incorporated with a capital of $10,000. M. Murphy and Wm. Murphy, of Manlius, and G. M. Corwin, of Oswego, are the directors.

KING'S PARK, N. Y.—The contract for installing new electric conduits and cables in buildings at the Long Island State Hospital here has been awarded to the Commercial Construction Co., New York City, for $5,235.

KINGSTON, N. Y.—Contracts have been awarded for the construction of a complete power plant and water works at the home of Colonel Astor at Ferncliff. The electrical equipment will include two 50-kw turbo-generators and a storage battery outfit.

NEW YORK, N. Y.—Bids will be received May 3, at the Bureau of Supplies and Accounts, Navy Dept., Washington, D. C., for furnishing at the navy yard here a quantity of electric motors, batteries, incandescent lamps and other material. H. T. B. Harris, Paymaster Gen., U. S. N., Washington, D. C.

WAYNESVILLE, N. C.—Engineers Ladshaw & Ladshaw, of Spartanburg, S. C., have received the contract for developing 1,000-hp on Pigeon River for B. G. Sloan, proprietor of the White Sulphur Springs Hotel. This power will be transmitted to Waynesville, N. C., and will be used for lighting and other purposes. W. C. Willard will have charge of the field work in the development at Waynesville.

VALLEY CITY, N. D.—At the recent city election the proposition to sell the electric light plant was not carried.

MOOSE JAW, N. W. TER.—Bids will be received May 14 by W. A. Munns, secretary and treasurer, Moose Jaw, for electric lighting equipment and engines. Willis Chipman is chief engineer, address 103 Bay St., Toronto, Ont.

NAPOLEON, OHIO.—Bids are wanted May 3 for $25,000 water and light enlargement bonds. E. W. Hilgendorff, is village clerk.

DAYTON, OHIO.—The Board of Public Service has adopted the report of the light committee and the city solicitor declaring the legality of the contract between the city and the Dayton Electric Light Company. It was noted in our issue of April 16 that Mayor Snyder had vetoed the ordinance granting the franchise.

WILMERDING, PA.—The Wilmerding Electric Light Co. is reported to have purchased a site on which it is proposed to construct a power plant.

SHENANDOAH, PA.—At a meeting between the stockholders of the People's Light, Heat & Power Co., of Shenandoah, and the People's Light, Heat & Power Co. of Mahanoy Township, it was agreed to merge the two companies into one and erect a plant with power enough to furnish light, heat and power for Shenandoah, Mahanoy City and other towns nearby. D. M. Graham is president.

BRYAN, TEX.—H. B. Dorsey writes that later on he may be in the market for electrical equipment for a lighting plant.

SHERMAN, TEX.—The Sherman Light & Power Co., of Sherman, has been incorporated with a capital of $100,000. Incorporators: M. B. Pitts, W. R. Brents and C. N. Roberts.

CASTLEDALE, UTAH.—W. E. Raines, of the Salt Lake Electric Supply Co., Salt Lake City, has submitted figures to the town boards of Orangeville and Castledale for an electric light plant to be used for lighting both towns. The probable cost will be $10,000

DAYTON, TENN.—The Dayton Lighting & Power Company is rebuilding its plant in this place.

WOODSTOCK, VA.—The Woodstock Electric Light & Power Company has been incorporated with a capital stock of $2,000 to $10,000.

VANCOUVER, WASH.—The Department of Columbia has decided to install electric light at the post here. The Vancouver Electric Light Company will probably receive the contract for a term of years. Arrangements are being made to purchase a new 500-hp engine to supply the required power.

SPOKANE, WASH.—George Nixon has been awarded the contract for the complete installation of the Waterville transmission plant. The available water power on the Enteat river is 3,000-hp, and the present development is for 250-hp. Three-phase current at 6,600 volts will be transmitted to Waterville, 9 miles distant.

WESTON, W. VA.—The Weston Electric Light, Power & Water Company will double the capacity of its plant during the coming summer and will install either a turbine or gas engine, direct-connected.

FENNIMORE, WIS.—The City Council has decided to install an electric light plant in connection with the city water works.

FOUNTAIN CITY, WIS.—Messrs. H. and F. Roettiger, owners of the electric light plant here, propose to install another dynamo.

HARTFORD, WIS.—The Hartford Electric Company may get the contract for street lighting, in which case its plant will have to be remodeled.

EAU CLAIRE, WIS.—The question of constructing a municipal electric light plant is under consideration. Emmet Horan is chairman of the committee.

WAUSAU, WIS.—The Hackworthy Construction Co., of Appleton, has secured the contract for building the new electric light plant at Wausau, for about $20,000.

ST. FRANCIS, WIS.—The board of directors of the St. Aemilianus Orphan Asylum has voted to install a new electric light plant including generating outfit and probably some changes in the heating system. George W. Colles, of Milwaukee, is engineer.

MANITOWOC, WIS.—The West Side Electric Power & Lighting Company has been organized with a capital of $25,000. A large plant will be erected here, which will be equipped by the Milwaukee Electric Co. Incorporators: Wm. Rahr, Sr., and Wm. Rahr, Jr.

THE ELECTRIC RAILWAY.

WOODBURY, CONN.—The Woodbury & Seymour Street Railway Company will establish an electric lighting plant and has developed for that purpose a water power.

MIDDLETOWN, CONN.—The franchise of the East Lynne Street Railway Company has been purchased by Morgan & Phelps, a New York firm. The company will be capitalized at $150,000. The new owners are having surveys made, after which the contracts will be let.

CHICAGO, ILL.—The contract has been let to the Arnold Electric Power Station Company, of Chicago, for the new power station of the Chicago & Milwaukee Electric Railway at Highwood, Ill. The building will cost about $150,000 and the equipment will include Allis-Chalmers engines, the electrical apparatus being of the General Electric Company's make.

BLOOMINGTON, ILL.—The stockholders of the Bloomington-Lincoln-Springfield-Peoria Interurban Company held their first annual meeting here a few days ago. The newly elected directors elected the following-named officers: President, La Fayette Funk; vice-president, S. E. Prather. A preliminary survey and the securing of right of way will be undertaken at once.

ALEXANDRIA, IND.—The promoters of the Oil Belt Traction Company are having a survey made of the line to connect Alexandria, Hartford City and Celina, Ohio.

MOORESVILLE, IND.—The Town Council is attempting to extend the city limits so as to include the power house and car houses of the Indianapolis & Martinsville Traction Company for taxation purposes. The company has $100,000 worth of machinery in the power house. It is said the company has threatened to dismantle and remove the power house if the town limits are extended.

CLINTON, IA.—The State Electric Street Railway Company has been granted a franchise and will spend $150,000 in rebuilding and equipping the line. The Illinois & Iowa Company has let contracts for power and operating equipment.

NEW ORLEANS, LA.—An ordinance has been introduced in the City Council of New Orleans authorizing the sale of a franchise for the construction of an electric railway in Algiers.

NEW ORLEANS, LA.—At a special meeting of the New Orleans & Carrollton Railroad Light & Power Company and the St. Charles Railroad Company it was separately decided to grant to the New Orleans Railways Company a lease of their properties until 1962. The lease will not be executed, however, until the injunction now pending against such action has been dissolved.

SKOWHEGAN, ME.—The Skowhegan & Norridgewock Electric Railway has been sold at auction to Amos K. Butler for $10,500. This road was built in 1894 at a cost of $56,000, and over $10,000 has been expended on it since. The town has $10,000 worth of stock.

WORCESTER, MASS.—The Boston & Worcester Street Railway Company is installing two 500-kw rotaries, one at the South Framingham power station, the other at the Westboro sub-station.

NORTH ADAMS, MASS.—Vice-President A. H. Rice, of the Hoosac Valley Street Railway Company, will, on May 1, it is announced, succeed Col. F. S. Richardson as president. The directors have voted to ask for authority to increase the capital stock by $100,000.

WORCESTER, MASS.—At the annual meeting of the Worcester & Webster Street Railway Company the following officers were elected: Edgar S. Hill, president; J. B. Potter, treasurer; Harry E. Back, clerk; the above and George A. Carmichael and W. F. Little, Worcester; E. N. Sanderson, New York; Harry E. Back and Samuel Anderson, of Danielson, Conn., directors. The general statement was made that the company has had a successful year. The company's property is used as a portion of the Worcester & Connecticut Eastern Railway Company.

GREENWOOD, MISS.—A meeting of the incorporators of the Greenwood Electric Railway Company was held here. A temporary organization was perfected and the subscription books closed. The officers elected were Gen. Monroe McClurg, president; Samuel J. Stein, first vice-president; Richard T. Jones, second vice-president; Rowan Thayer, secretary and treasurer; H. G. Kitchell, consulting engineer. A part of the capital was paid in, and the work will be given immediate attention.

JEFFERSON CITY, MO.—The Lexington & Suburban Railway Company, of Lexington, has been chartered with a capital of $250,000, owned chiefly by Mr. Gustave Haerle, of Lexington. The other stockholders are G. Hedrick, A. G. Sutherland, L. R. Ash and V. H. Cochrane, of Kansas City. The road is to be 25 miles in length, and will be run from Mayview.

TOLEDO, OHIO.—The Toledo & Northwestern Railway Company has been incorporated, with $10,000 capital stock, by C. W. Merrill, J. O. Ormond, R. W. Barton, Walter Gayhart and H. C. Adams.

WAUSEON, OHIO.—Samuel A. Wright, president of the Ohio Northern Traction Company, has obtained a franchise for the line through Wauseon. The road will extend from Adrian, Mich., to Defiance, Ohio.

WEST ALEXANDRIA, OHIO.—The Dayton & Western Traction Company is extending its power station at this place. The new equipment will include two 450-hp Hamilton-Corliss engines, two 250-kw generators and two 250-hp boilers.

TOLEDO, OHIO.—It is said that William Ford, of the Ohio & Michigan Traction Company, has just succeeded in floating the company's bonds to the extent of $4,500,000 in New York. The company proposes to build to Ann Arbor, Mich. Hirsch & Company are said to have taken the bonds.

TOLEDO, OHIO.—The Toledo Railways & Light Company is extending the boiler house at its main station in this city. A new smokestack will be erected. The Ricard Boiler Company, of Toledo, has been given the contract for four 650-hp water tube boilers. The plant will be equipped with automatic stokers, coal conveyors, etc., for the latter of which contracts have not yet been given out.

COLUMBUS, OHIO.—The Ohio Union Traction Company, the title of the company under which it is proposed to consolidate the various Appleyard interests in Ohio, has increased its capital stock from $10,000 to $700,000. This is to cover the mortgage recently given on the proposed new line from Findlay to Kenton, the last link required to complete the system between Cincinnati and Toledo.

GREENVILLE, PA.—S. G Bailey, of Pittsburg, has applied to the Borough Council for a street railway franchise.

HARRISBURG, PA.—Col. P. Russ, of this city, has a force of engineers surveying for the proposed electric railway from Mount Holly Springs to Gettysburg, a distance of about 22 miles.

COATESVILLE, PA.—Borough Council has passed the ordinance transferring the rights granted the Brandywine Electric Railway Company to the Philadelphia, Coatesville & Lancaster Street Railway Company.

CHAMBERSBURG, PA.—An extension of the town line of the Chambersburg & Gettysburg Electric Railway Company to Wilson College, a short distance from town, will be built this summer. The company's power house will be ready by June 1.

WASHINGTON, PA.—Ordinances asking for franchises for a proposed electric railway to connect Washington with Pittsburg will be introduced at the next meeting of Council. The line will connect with the Pittsburg & Charleroi line at Liberty, in Allegheny, and will be 15.4 miles long. The line is to form a link in a trolley system from Pittsburg to Wheeling.

LITTLE COMPTON, R. I.—The Town Council of Little Compton has granted to the South Shore Street Railway Company a franchise to lay rails and operate a railway in the town.

ANDERSON, S. C.—This place is to have an electric railway. J. A. Brock, R. S. Ligon and others are the promoters. One hundred thousand dollars is the estimated cost. The line will be extended to the mill villages, near the city.

SAN ANTONIO, TEX.—The San Antonio Traction Company contemplates making extensive improvements in its lines. Chief among these will be the rebuilding of the entire West End line. The making of these and other improvements by the Traction Company depends on the action of the City Council, and if that body reports favorably on the petitions of the Traction Company, operations are to be started immediately after the Carnival.

RICHMOND, VA.—Leading negro editors, physicians and ministers have formed a permanent organization here to boycott the street cars on account of the law recently passed allowing conductors to compel passengers to take such seats as they may designate. The negroes were advised to keep away from the theatres, which they must enter by a side entrance leading to a small gallery. The negro ministers are preaching sermons on the proposed boycott.

GUELPH, ONT.—The Street Railway Commissioners are considering the installation of a storage battery plant.

NEW INDUSTRIAL COMPANIES.

THE JONES FAN & MOTOR COMPANY has been incorporated in New York with a capital stock of $2,500. The directors are C. D. Marsh, L. A. Landau and James Jones, Jr., all of New York.

THE INDUSTRIAL TRANSPORTATION COMPANY has been incorporated at Washington, D. C., with a capital stock of $1,000,000. The incorporators are Edward Lugo-Vina, Edward D. N. Whitney, W. A. Copenhaver, Samuel H. Moore and E. L. Mattice.

THE AMERICAN SWITCH & SIGNAL COMPANY has been incorporated in Yuma, Ariz., for the purpose of building railroads, telegraph and telephone lines, electric railways and operating devices pertaining to switches. The capital stock is $1,000,000, and the incorporators are A. J. Gutzler, W. A. Bondurant, H. MacDavenport and others.

THE INDIANA & MICHIGAN ELECTRIC COMPANY has been incorporated in Jersey City, N. J., with a capital stock of $2,000,000. The incorporators are George W. Flaake, Jr., H. H. Porter, Francis Blossom, H. L. Cranford, Lyman L. Dyer Frederick V. Delafield, Frederick W. Longfellow, Henry S. Colwell and Harold S. Mackays.

THE AUTOMATIC MONITOR COMPANY has been incorporated at Toledo, Ohio, by Charles D. Miller, Morgan Levi, E. M. Taylor, H. R. Ashbrook, D. A. Yoder and S. Sanger. The company will manufacture a device to register the time consumed after the telephone receiver is lifted from the hook until the operator answers the call, and also record the time consumed in conversation over a long distance line.

LEGAL.

TELEPHONE WAR TAXES.—The United States Circuit Court of Appeals, sitting in New York City, has held that Spanish War taxes to the amount of $21,492, paid up on messages by the New York Telephone Company, are not to be refunded. The company sued Internal Revenue Collector Treat for the recovery of the money, on the ground that the fees for messages, at 15 cents each, according to the contracts with subscribers, were really based on the cost of maintaining wires and other expenses. It was held that the Government, in taxing messages, should not have levied its tax upon the full amount which the company collected from subscribers. The Court ruled that the company, by altering the phraseology of its contracts, might have escaped the tax but had not done so and was clearly liable.

LIGHTING AT DAVENPORT, IA.—An interesting case of some years standing has just been decided on appeal by the Supreme Court of Iowa. In 1896 the Davenport Gas & Electric Company made a contract with the city for 25 years which it proceeded to carry out until 1901, when it was ordered to install an alternating current system with alternating enclosed arcs in place of its direct current system. It did not do this, whereupon the city council nullified the contract franchise. The company has been sustained in its defense of its rights. The court says: "But, in addition to the finding of fact, which would alone determine the question in favor of plaintiff, we do not believe the ordinance contemplated such a change as was demanded. It will be remembered that the plaintiff installed a plant complying with the specification of the ordinance, and put in a large amount of new machinery at great expense, which the evidence shows would be rendered useless by the installation of the alternating system. The ordinance provides that at the commencement of each five-year period the city may require 'that all such machinery and appurtenances are in good condition and of such approved design as shall efficiently and properly produce gas and electric light of the required standard and power, and give the city and the citizens thereof the advantages of all improvements in the production of gas and electricity.' The machinery and appurtenances supplied under the required direction of the city were to be inspected, and required to be in good condition, and of such design as to furnish light of the 'standard and power' already designated, so that the city should have the advantage of all the improvements calculated to increase the efficiency of the system then in use. This construction is warranted from a consideration of the entire ordinance and in view of the fact that it is very improbable that either the city or the plaintiff contemplated that demands might be made at the beginning of each five-year period which would require an entire change of machinery and appurtenances, no matter how great the expense."

PERSONAL.

M. FRANK TRUMBULL, of the Trumbull Electric Company, has gone on an extended trip to Cuba, Porta Rico and Mexico.

MR. C. H. HINES has severed his connection with the Canadian Pacific Railway Company as electrical engineer of the mechanical department, etc.

DR. CARY T. HUTCHINSON, consulting electrical engineer, has sailed for Europe, and will, it is said, spend two or three months on the other side.

MR. M. I. WILBERT, of the German Hospital, Philadelphia, is to lecture this week before the Franklin Institute on the phenomena of radioactivity and their applications, with illustrations.

MR. JOHN B. ALLAN, general manager of sales of the Allis-Chalmers Company, has resigned his position and expresses his intention of taking a vacation for a couple of months, in order to recuperate.

MR. J. T. P. KENYON has resigned from the engineering department of the New York Edison Company to become chief draughtsman of the electrical department of the New York Central & Hudson River Railroad.

MR. ANDREW CARNEGIE has created a $5,000,000 pension fund, the income of which is to be devoted to the relief from immediate suffering of the heroes in private life who sacrifice themselves in performing acts of courage to save others.

MR. C. C. GARRISON is now president of the Northern Engineering Company, Incorporated, White Building, Liberty Street, New York. Mr. C. Blake Garrison has been elected treasurer and Mr. B. R. Andrews has been appointed secretary of the concern.

MR. ARTHUR WEST, assistant chief engineer of the Allis-Chalmers Company, has resigned his position, and will go to the Mediterranean for a holiday trip. In his letter of resignation he says: "For the last couple of years I have been regularly overworked and my most urgent need is rest."

LIEUT. G. L. CARDEN, of the Department of Machinery, St. Louis World's Fair, lectured at Yale University on April 22, and the following evening in the auditorium of the new Y. M. C. A. building, New York, the subject being "Power Plant at St. Louis, and Some European Observations."

MR. SEYMOUR FOLWELL, at one time manager of the New York office of the British electrical engineering and contracting firm of Robert W. Blackwell & Company, Limited, and until reecntly connected with the sales department of the Cutter Company, of Philadelphia, is again on this side.

MR. WM. BARCLAY PARSONS, chief engineer of the New York Subway after an inspection of the Panama property, says the waterway can be successfully operated. Colon and Panama can be made healthful, he says, by sanitary precautions. He is a member of the U. S. Panama Canal Commission.

MR. WM. STANLEY, of Great Barrington, Mass., has recently taken a trip to Paris, France, in connection with some recent important work. The Pittsfield newspaper says that these new patents "propose to give the sun more vim and hang a new moon." We had thought that to be Mr. Tesla's special prerogative.

MR. A. M. MATTICE, chief engineer of the Allis-Chalmers Company has sailed for England this week on a brief business trip. He was accompanied by Mr. Fullagar, of the British turbine syndicate, who has been here for a few weeks, at Milwaukee, etc., in connection with Allis-Chalmers steam turbine development.

MR. FRANCIS BLOSSOM, of Sanderson & Porter, Kuhn-Loeb Building, New York, is expected back from New Orleans early next week where he went recently in connection with the New Orleans Railway Company's project to construct a new power plant to have an initial capacity of 7,000-hp and an ultimate development of 20,000-hp.

MR. WILLIAM N. SCOTT, manager of the Cutter Company of Philadelphia, has sailed for Europe for the purpose of closing some important contracts for circuit breakers, notably with the British Admiralty. The Cutter Company is represented in England by Robert W. Blackwell & Company, Limited. Mr. Scott expects to be abroad for about two months.

MR. JOHN I. BEGGS, president and general manager of the Milwaukee Electric Railway and Light Company, was presented by the officers and directors with a silver service in token of the esteem in which he is held by them at a banquet given for him on April 16. The silver is intended to form part of the equipment of a private car which is now being built for the use of Mr. Beggs.

MR. G. MARCONI.—Mr. Marconi, who has been interviewed by the *St. James's Gazette* on the question of his transatlantic "wireless" service says that his agreement with the Post Office which will be signed almost immediately, concedes all that his company has been asking for during the past few years. "As soon as the agreement has been signed," he added, "we shall start the service both to Canada and the United States."

MR. UGARTE, of the Mexican electrical engineering firm of Ugarte & Garcia, of Guadalajara, State of Jalisco, is now on his way to the States. His firm recently secured the contract for the construction of the electric lighting system in Colima, capital of the State of that name. Contracts have also been taken for the equipment of various hydraulic plants in the States of Jalisco and Coahuila, which will mean the purchase of considerable quantities of Yankee machinery, etc. Mr. Ugarte will visit St. Louis, Chicago, Pittsburg, and New York.

MR. C. A. MORENO, chief engineer of the St. Louis Transit Company, read a paper before the Engineers' Club of St. Louis, at its recent meeting, on the proposed method of handling visitors at the exposition. "The Transit Company, alone," he said, "will be able to take care of 50,000 passengers every hour. The Suburban Company has estimated its capacity of 10,000 per hour. The shuttle trains of the Wabash will accommodate 15,000 passengers per hour, making the total of 75,000. In fact, it would seem that the chief difficulty of the three Exposition lines will be—not how to take care of the people, but rather how to obtain enough passengers to take care of the new equipment that has been provided."

MR. ERVIN DRYER has resigned his position in connection with the Westinghouse Electric & Manufacturing Company, and has accepted an appointment with the Allis-Chalmers Company. Mr. Dryer's connection with the Westinghouse Company extended over a period of 16 years. He is one of the most competent salesmen in the electrical and mechanical field, and his wide acquaintance throughout the western part of the United States will be of great service to the Allis-Chalmers Company in the extensive new developments which they have undertaken. He has already entered upon his new duties with the Allis-Chalmers Company, and his headquarters will be at their offices in the New York Life Building, Chicago. He will give his attention to their engine work as well as to the sale of Bullock electrical apparatus, which the Allis-Chalmers Company now control through their acquisition of the Bullock Electrical Manufacturing Company, of Cincinnati.

DR. W. J. MORTON, the celebrated electro therapist of this city, has just sustained a deep personal bereavement in the death of his mother, Mrs. Elizabeth Morton, widow of Dr. W. T. G. Morton, discoverer of anesthesia, who died last week in this city at the Hotel Martha Washington, of pneumonia, following an illness of more than a year. Mrs. Morton, born in 1826, was married in 1844 to Dr. Morton, of Boston, Mass. A year of quiet married life had scarcely elapsed when her husband began that series of experiments upon

lower animals, upon himself, and, finally, upon patients, which culminated in the great public demonstration that painless surgery by the inhalation of ether vapor was safe and practicable. No recognition of any sort from the American Government ever came to his widow, although the reports of six Congressional committees during her husband's lifetime had recommended an appropriation of several hundred thousand dollars be made in compensation for the Government's use of ether anesthesia during the civil war. A monument to his memory was erected on Boston Common, and other public tributes have since been made.

LORD KELVIN.—We quote the following from the *Manchester Guardian:* Lord Kelvin's election to the lord chancellorship of Glasgow University has loosened the flood of anecdotes which have gathered round his great name. I may be allowed to add two stories to that respectable record which have not, I think, seen print. Most Kelvin stories which obtain in Glasgow are founded upon the occasional inability of the great man who lisped in logarithms to bring his mind to a childish sum. The famous one tells how on his blackboard he once made two and two five, and, hearing the chuckles of his delighted class, altered it hastily to three. He was, however, once heard to say, in his characteristic slow way, with his beautiful use of the soft Irish r, "Seven times nine, Mr. Mac-far-lane, are a hundred and what? [Pause.] But, no; seven times nine cannot be a hundred and anything, Mr. Mac-far-lane, for the square of a hundred is ten." It is also told of him that, walking one day with a friend in Largs, he noticed that it had begun to rain. He questioned his friend closely as to where his coat and his umbrella were, and having satisfied himself that his friend had not these articles with him, he said: "Well, in that case, doctor, we will walk back beneath this belt of trees, for the rain will not per-colate the leaves, doctor, for twen-ty minutes."

MR. G. C. LLOYD.—Mr. George C. Lloyd has been appointed to the secretaryship of the British Institution of Electrical Engineers. Born in Lincolnshire in 1862, his father being the Rev. C. A. Lloyd, Rector of Rand, near Lincoln, Mr. Lloyd was educated partly in Germany, and on returning to England at the age of 17, he entered the works of Robert Stephenson & Co., locomotive and marine engine builders, Newcastle-upon-Tyne, as an apprentice. In 1884 he joined the firm of Messrs. Lamport and Holt, of Liverpool, in the capacity of marine engineer, and subsequently entered the service of the Spanish Royal Mail Steamship Co. (Compañia Transatlantica de Barcelona). He holds an extra first-class Board of Trade certificate. In the course of his voyages he visited the Philippine Islands five times, making a stay of one month on each occasion, and has also been in India, Brazil, the Argentine Republic and the West Indies, spending some three months in Cuba before the outbreak of the rebellion. He returned to England in 1891, and for the next nine years was engaged in engineering work in Glasgow and London. Since 1900, Mr. Lloyd has acted as chief assistant to the secretary of the Iron and Steel Institute. Mr. Lloyd is an excellent linguist. He enters on his duties on May 12th. Mr. Percy F. Rowell, chief assistant to the late Mr. McMillan, has been appointed assistant secretary.

NEW INSTITUTE MEMBERS.—At the April meeting of the Council of the American Institute of Electrical Engineers the following were elected to associate membership: Allen, Claxton Edmonds, assistant engineer General Electric Co., Lynn, Mass.; Appleton, Joseph, manager of construction, Electric Storage Battery Co., Philadelphia, Pa.; Berg, Edwin Victor, draughtsman, Telluride Power Co., Provo, Utah; Bott, George Robert, chief draughtsman, American Elevator Co., Columbus, Ohio; Boyd, Alexander A., general manager Michigan City Electric Co., Michigan City, Ind.; Bryant, Arthur Horace, tester Lamp Testing Bureau, New York City; Coggin, William Lord, tester General Electric Co., Lynn, Mass.; Cope, Albert Nathan, electrical engineer, Columbus Public Service Co., Columbus, Ohio; Costa, Louis J., manager, Jandus Electric Co., 1419 Real Estate Building, Philadelphia, Pa.; Crankshaw, J. B., resident engineer, Cincinnati Engineering and Investment Co., 1406 Traction Building, Cincinatti, Ohio; Crane, Charles Eugene, president and manager, Mutual Light & Heat Co., Seattle, Wash.; Davenport, Alfred La Rue, tester, Edison Electric Co. of Los Angeles, Long Beach, Cal.; Davis, Richmond Pearson, instructor, School of Submarine Defense, Fort Totten, N. Y.; Fenn, Ernest James, Steuart & Fenn, Dunedin, N. Z.; Fletcher, Raymond Fennimore, electrical engineer, McMaster and Fletcher, Columbus, Ohio; Griffin, Frank Albee, engineer, General Electric Co., Schenectady, N. Y.; Gillet, Louis Allston, assistant to secretary, American Society of Mechanical Engineers, New York City; Gresham, William Andrew, chief dynamo man, Georgia Electric Co., Atlanta, Ga.; Griffin, Thomas Lloyd, agent, General Electric Co., Wilkesbarre, Pa.; Hale, William Buell, laboratory chief, Western Electric Co., 259 S. Clinton St., Chicago, Ill.; Hedin, Kaleb, electrical engineer, Vesteras, Sweden; Hilbert, Alfred, draughtsman, S. M. Bixby, 1173 Fulton Ave., Bronx, New York City; Holland, Newman Henry, telephone engineer, Holtzer Cabot Electric Co., Wollaston, Mass.; Hulme, Frederick Wendell, electrical engineer, Hydro-electric Co., West End Hotel, St. Louis, Mo.; Johnston, D. McG., electrical engineer, The United Electric Co., Ltd., Toronto, Can.; Kaiser, Louis Theo., chief engineer, Thos. Emery's Sons, Hotel Emery, Cincinnati, Ohio; Kenyon, A. D., patent counsel, Kenyon and Kenyon, 49 Wall St., New York City; Kenyon, William Houston, patent lawyer, 49 Wall St., New York City; Lohman, Frank Henry, electrician, Calumet and Arizona Mining Co., Douglas, Ariz.; McBurney, Bruce Gordon, salesman, Canadian General Electric Co., Toronto, Ont.; McCall, Joseph B., president, The Philadelphia Electric Co., Philadelphia, Pa.; McMasters, James Clayton, McMasters and Fletcher, Columbus, Ohio; McNamee, Thomas Wilson, superintendent, Wabash Electric Light Co., Wabash, Ind.; Merrill, Meldon Humphrey, sales engineer, Westinghouse Electric and Mfg. Co., 716 Board of Trade Building, Boston, Mass.; Mettler, Hans Willi, draughtsman, Chicago Edison Co., Chicago, Ill.; Milch, Maurice, engineer, General Electric Co., Schenectady, N. Y.; Mitchell, Arthur Jesse, Southern representative, Adams Bagnall Electric Co., 323 Empire Building, Atlanta, Ga.; Mustard, John, manager, Wagner Electric Mfg. Co., 1617 Real Estate Trust Co., Philadelphia, Pa.; Newman, Mortimer Lewis, electrician, Dept. of Yards and Docks, Navy Yard, New York City; Nishikawa, Kikei, chief electrical engineer, Bessi Copper Mine, Iyo, Japan; Ovington, Earle Lewis, president, Ovington Mfg. Co., 4 Newcastle Court, Boston, Mass.; Phillips, Irving Wadsworth, student, General Electric Co., West Lynn, Mass.; Plaisted, Arthur I., engineering inspector, Metropolitan Water and Sewer Board, E. Somerville, Mass.; Reed, Frederick Holly, vice-president, J. G. White & Co., 43 Exchange Place, New York City; Richardson, Joseph W. A., contractor, 715 Union St., New Orleans, La.; Riggs, Walter Merritt, professor, Electrical Engineering, Clemson Agricultural College, Clemson College, S. C.; Salomon, Arthur F., manager, World's Fair Office, Nernst Lamp Co., St. Louis, Mo.; Schafer, Oliver Milton, superintendent, Fire Alarm and Police Telegraph, Trenton, N. J.; Shaw, Fred Menzies, tester, General Electric Co., Lynn, Mass.; Strohman, William, designer, Westinghouse Electric and Mfg. Co., Pittsburg, Pa.; Snyder, Henry Nicholas, superintendent, Santa Paula Electric Co., Santa Paula, Cal.; ter Meulen, F. W. von Lilienstern, assistant engineering, Westinghouse, Church, Kerr & Co., New York City; Tobey Jesse Orion, superintendent, Northern California Power Co., Manton, Cal.; Tomlinson, Harvey Strout, tester, General Electric Co., Lynn; res. Salem, Mass.; Tsukamoto, Chuzaburo, calculator, General Electric Co., Schenectady, N. Y.; Van Etten, Herbert Briant, assistant engineer, New York Telephone Co.; Vickers, Frederick Elwood, expert, General Electric Co., Los Angeles, Cal.; Wheeler, Burr, student, Columbia University, New York City; Wilgus, William John, fifth vice-president, New York Central and Hudson River R. R., New York City; Wilmerding, Charles Henry, consulting engineer, Room 1100, 84 Van Buren St., Chicago, Ill.; Yundt, George Jacob, electrical engineer, Southern Bell Telephone and Telegraph Co., Atlanta, Ga.; Zimmerman, Clarence Irving, assistant chemist, Nernst Lamp Co., Pittsburg, Pa.

Trade Notes.

BUFFALO FORGE COMPANY, of Buffalo, N. Y., has brought out a new eight-page, small size pamphlet devoted to its Buffalo hand blowers. Copies can be obtained on application.

THE FORT WAYNE ELECTRIC WORKS have opened a Pacific Coast branch office in San Francisco, Cal. Mr. F. V. T. Lee is manager of this office, which is located at 69-75 New Montgomery Street.

THE MACKAY ENGINEERING COMPANY, 149 Broadway, New York, announces that it has withdrawn from the arrangement whereby it represented the dynamos and motors of the Akron Electrical Mfg. Company.

YOST SOCKETS.—The Electrical Equipment & Supply Company, of 215½ Fourth Avenue, Pittsburg, Pa., has just assumed the representation of the Yost Electric Mfg. Company, for its socket specialties, etc., in Pittsburg and vicinity.

EMERSON ELEC. MFG. CO., St. Louis, Mo., has just issued a new bulletin as to its bi-polar direct current motors, ⅛ to ⅓-hp. These are of the enclosed cylindrical types TD62 and TD52 and are stout power motors with a heavy reserve, overload capacity. Two sizes of frames are used.

THE BROWN HOISTING MACHINERY COMPANY, of Cleveland, Ohio, has closed a contract for electric coal trimming machinery for the docks of the Hocking Valley Railway Company, at Toledo, Ohio. It is stated that this will be the first trimming coal machinery installed on the Lakes. It will effect a great saving in the handling of fuel.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, manufacturer of the Cross oil filter, has just received an order from the Russian government for six oil filters, this being the tenth order from that government. These filters have acquired a reputation throughout Europe and the company is constantly making continental shipments.

GOULD STORAGE BATTERY COMPANY.—Mr. W. W. Donaldson, sales manager of the Gould Storage Battery Company, of 25 West 33d St., New York, announces that the company will move about May 1, and that on and after that date it will occupy the entire eighth floor of the New Century Building, 1 West 34th Street.

THE NEWMAN-WILLSON COMPANY, Lambertville, N. J., is manufacturing an oil filter which is claimed to save 50 per cent on an oil bill; saves 90 per cent of the oil, and, being automatic, requires little attention. Its merits will prove of interest to all having use for such a device. This company is composed of Messrs. W. S. Newman and E. L. Willson.

THE INTERNATIONAL TELEPHONE MANUFACTURING CO., Chicago, reports a constantly increasing demand for its long distance bridging toll line and country party line telephones for four-party selective signalling systems. The "International" bridging instrument is said to be, mechanically as well as electrically, one of the very best instruments of its kind.

THE UNITED TELPHERAGE COMPANY, 20 Broad Street, New York City, which has already done a large amount of heavy and light telpherage work with motor traveling on an aerial line, has now brought out an ingenious modification of its system for advertising purposes. The "ad" is suspended below the telpher, which travels up and down its track parallel to any railroad trolley line, highway, etc., thus attracting attention.

NILES-BEMENT-POND COMPANY, 136 Liberty Street, New York City, is issuing a neat "Progressive Reporter," illustrative and descriptive of its latest machine tools. The issue just received shows a 48-inch double planer, 60 inch double rotary planer hydraulic bar shear, hydraulic punching machine, horizontal milling machine, 68-inch slotting machine, new model turret lathe, 400-ton hydraulic wheel press, Corliss cylinder boring machine and motor driven horizontal machines.

THE ELECTRICAL TESTING LABORATORIES.—The fact should be generally known that the title of the corporation heretofore known as the Lamp Testing Bureau has been legally changed to be Electrical Testing Laboratories, and that the new corporation is in every respect the legal successor of the other, without change of officers or functions. The offices and laboratories have now been removed from No. 14 Jay Street to Eightieth Street and East End Avenue, New York.

WARNING.—We are advised by the General Electric Co. that a person calling himself Geo. E. McCante, and describing himself on his card as chief

electrician of the General Electric Co., Schenectady, N. Y., is traveling in Texas and making representations that he is connected with the company. We are requested to state that there is no one of this name on the payroll of the General Electric Co. It is needless to add that no such person was ever its chief electrician.

BISSELL SIGN FLASHER.—The F. Bissell Company, of Toledo, O., reports that it is having a large sale of its new sign flasher for advertising purposes, etc. The regular design has 24 circuits, all or part of which may be used, while more circuits can be added. The contracts are made and broken by quick-break knife switches. The regular switch throws in lights one at a time until the entire sign is illuminated; but this effect can be varied. A catalogue will be sent on application.

LAMBERT SCHMIDT TELEPHONE MFG. COMPANY, of 85-93 Maple Street, Hoboken, N. J., has just issued catalogue No. 11 devoted to its well-known interior telephones. It is a handsome pamphlet of 24 pages and illustrates and describes its apparatus fully, all being intended to work primarily on the company's patented central energy circuit which requires but one bank of batteries, located at any convenient point. Only three more wires than telephones are necessary. A long list of users is also given.

CROCKER-WHEELER BRANCH IN NEW ORLEANS.—Crocker-Wheeler Company, manufacturers of electric generators and motors, will on May 10, open a branch office in the Hibernia Bank Building in New Orleans. Mr. W. P. Field, of the St. Louis office of the company, will be the representative in charge. Although there are 15 Crocker-Wheeler branches from Boston to San Francisco, including St. Louis and Atlanta, the establishment of this new office has become necessary in order to accommodate the steadily increasing market for electric machinery in the South and Southwest.

LAMP CONTRACTS.—"The contract method every time," says the Electric Appliance Company, Chicago, to people who are going to purchase lamps. "Whether a consumer's requirements call for one thousand, ten thousand or a hundred thousand lamps, he should buy them on contract and so be assured of the best price and best service." The company has just closed contracts with two of the largest consumers in the west for the Packard high-grade lamps and recommends all its customers to secure lamps on the contract basis.

THE WIRT ELECTRIC COMPANY is making arrangements to move into its new plant at the corner of Germantown Avenue and Pennsylvania Railroad tracks at North Philadelphia. It expects to get into its new building by May 1. This building gives it much more space than it at present has, and is arranged so that it has light on every side on every floor. The building is brick, of the modern mill construction. It may take the Wirt Electric Company a few days to get settled in its new shop, but it expects by May 7 to be running in its new quarters to its fullest capacity.

THE PUBLICATION DEPARTMENT of the B. F. Sturtevant Company is to receive generous recognition in the allotment of space in the new office building at Hyde Park, Mass. A portion of the high basement, about 40 ft. square, will be devoted to a press room and storage space for paper stock and printed matter. A full equipment of type and of jobbing and catalogue presses will be installed. Immediately above this room and occupying one end of the first story of the same building, will be the offices with a full complement of artists, clerks, etc. The Sturtevant Company has for several years maintained a printing plant of its own, and is to-day carrying through all the work required in connection with its publications except the engraving. This department will be one of the most extensive and progressive connected with any manufacturing concern of its character in the country.

LOW-SERVICE COMPRESSORS FOR AIR AND CARBONIC-ACID GAS. A 12-page pamphlet, published by the Laidlaw-Dunn-Gordon Company, of 114 Liberty St., New York City, describes compressors intended for pressures of 30 lbs. and under. These compressors are built with open suction for supplying air at low pressure, or with closed suction for handling carbonic acid and other gasses. The inlet valves are of the semi-rotary type, while the outlet valves are of the poppet type. Rotary valves are considered superior for inlet service, not only because of their greater efficiency and durability, but furthermore because they open promptly and offer no resistance to the incoming air, which the poppet valve held down by a spring must necessarily do, thus cutting down the volume capacity of the compressor. The discharge valves, on the other hand, present a different problem, owing to the fact that the point of opening should vary with variations in pressure, and the poppet type has been adopted for this service.

"BIAS LINOTAPE."—The Mica Insulator Company, of New York and Chicago, is now placing on the market an entirely new product under the trade name "Bias Linotape." This material is, as its name suggests, a tape cut on the true bias and coated with a film of its Empire oxidized linseed oil. It is extremely flexible and can be wrapped around sharp corners and turns where straight tape cannot be used. It is designed especially for use in insulating armatures, field magnet coils, cables, switchboards and high tension work, as well as in other places where a high grade of electrical and mechanical insulating tape is required. The manufacturer is distributing small samples of this tape and announces its willingness to mail the same upon application. It filled some very large orders for the goods recently, and the trade seem to be very enthusiastic regarding them. This company reports increased sales in its standard lines of micanite, Empire and M. I. C. compound materials which it originated and brought out ten years ago.

BRISTOL EXHIBIT AT ST. LOUIS.—The Bristol Company, of Waterbury, Conn., is sending an exhibit to St. Louis which will be placed in Electricity Building, in space 36, near the main entrance. The company will show a complete line of its recording instruments for pressure, temperature and electricity. These instruments will be shown in various styles and sizes and in different finishes. The construction and operative parts will also be shown and a large number of the instruments will be in actual operation, enabling visitors to observe the manner of operation and the records the instruments make, also the extreme simplicity of the different instruments and the delicacy and accuracy which it is possible to obtain without sacrificing any of the necessary elements which are essential in a commercial form of a recording instrument. There will also be shown a complete line of specimens of Bristol patent steel belt lacing which comprises over 150 different sizes for all kinds of belting from the thinnest to the heaviest that is made, such as is used for conveying belts.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED APRIL 19, 1904.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

757,557. ELECTROLYTIC DEPOSITION APPARATUS; William J. Joly O. App. filed June 18, 1903. Where the terminals of main wires are to be moved from time to time to follow the movements of a machine supplied through branch wires from the mains, the mains terminate in coils wound upon spools, which are supported upon a portable bracket; as the bracket is moved about the reels give off the main wires.

757,441. CLUSTER SOCKET; John H. Dale, New York, N. Y. App. filed Feb. 18, 1904. The finishing cap containing the openings for the lamp bases, supports inside, a block of insulating material to which all of the lamp terminals are attached, and by removing the cap from its support, the two binding posts for the line wires are exposed.

757,495. ELECTRIC SOLE SHOE; Adam Reed, St. Joseph, Mo. App. filed Feb. 4, 1904. Copper and zinc plates are arranged in a porous insole.

757,503. TELEGRAPH SYSTEM; Harry O. Rugh, Chicago, Ill. App. filed Aug. 31, 1903. This patent and those following in the same name provide a system and apparatus whereby wave-form current, as alternating current of suitably high frequency, may be employed in effecting telegraphic signals. The same circuit may be employed simultaneously for both direct and wave-form currents.

757,504. TELEGRAPHIC SYSTEM; Harry O. Rugh, Chicago, Ill. App. filed Aug. 21, 1903. See No. 757,503.

757,505. TELEGRAPHY Harry O. Rugh, Chicago, Ill. App. filed Aug. 31, 1903. See patent 757,503.

757,515. PHASE REGULATION; Egbert M. Tingley, Wilkinsburg, Pa. App. filed May 9, 1896. This patent and those following in the same name provide for securing a desired phase angle between the shunt and series fields when there is no current lag in the work circuit by displacing the current in one of the field coils with reference to that in the other or in both of said coils.

757,516. PHASE ANGLE ADJUSTING MEANS; Egbert M. Tingley, Pittsburg, Pa. App. filed April 24, 1900. See preceding patent.

757,517. METHOD OF PHASE ANGLE ADJUSTMENT; Egbert M. Tingley, Pittsburg, Pa. App. filed April 24, 1900. See patent 757,515.

757,518. METHOD OF PHASE ANGLE ADJUSTMENT; Egbert M. Tingley, Pittsburg, Pa. App. filed Feb. 4, 1901. See patent 757,515.

757,523. INDUCTION COIL; Richard Varley, Providence, R. I. App. filed Dec. 14, 1903. The sectional secondary winding is placed as usual axially over the primary winding and core and is inclosed in a porcelain cylinder having an inwardly projecting flange which enters between the sections of the secondary winding, the latter being so wound that the sections are connected together at the inner layers, so that the points of greatest difference of potential will be separated by the partition

757,524. INDUCTION COIL; Richard Varley, Providence, R. I. App. filed Dec. 30, 1903. A porcelain or glass cup passes over one end of the primary winding and core and is itself surrounded by one section of the secondary winding, the other section being placed around the uncovered portion of the primary and core, the whole being inclosed in a porcelain cylinder or cup.

757,525. INDUCTION COIL; Richard Varley, Providence, R. I. App. filed Jan. 12, 1904. A number of Ruhmkorff coils are placed in a single box and their armatures arranged to act upon a vibrator common to all of them.

757,527. VIBRATOR FOR INDUCTION COILS; Richard Varley, Providence, R. I. App. filed Jan. 20, 1904. The contact screw of the vibrator is arranged to be tipped so that its platinum point can be exposed for inspection and cleaning whenever necessary.

757,537. METHOD OF SIGNALING FOR ELECTRIC RAILWAYS; Samuel M. Young, New York, N. Y. App. filed Nov. 6, 1903. Consists in creating a difference of potential between the traffic rails of the system which separately form return paths for the power circuit and over which a current differing in character is flowing, actuating signal devices by the current due to such difference of potential and shunting said current around certain of the signalling devices by the aid of apparatus actuated by the power current.

757,541. PUSH BUTTON SWITCH; Walter A. Church, Binghamton, N. Y. App. filed June 17, 1903. Details.

757,557. ELECTROLYTIC DEPOSITION APPARATUS; William J. Joly and Joseph H. Joly, San Francisco, Cal. App. filed April 7, 1903. (See page 821.)

757,559. WIRELESS TELEGRAPH SYSTEM; Guglielmo Marconi, London, England. App. filed Nov. 19, 1901. At a station employed in wireless telegraphy, a conductor, a number of open circuits electrically connected with the conductor, a corresponding number of instruments, one electrically connected with each open circuit and means whereby the time periods of the open circuit are caused to differ from each other.

757,564. ELECTRIC HEADLIGHT; William H. Northall, Elwood, Ind. App. filed March 20, 1903. The lamp can be "turned down" by adjusting the length of the arc between the carbons.

757,609. ELECTRICAL TELEPHONE APPARATUS; Pliny H. Fisk, Clay, Ia. App. filed June 13, 1903. (See page 822.)

757,617. PROCESS OF PRODUCING CARBIDE; William Smith Horry, Niagara Falls, N. Y. App. filed March 29, 1902. (See page 821.)

757,618. PROCESS OF ELECTRIC HEATING; William Smith Horry, Niagara Falls, N. Y. App. filed April 5, 1902. (See page 821.)

757,619. PROCESS OF ELECTRIC HEATING; William Smith Horry, Niagara Falls, N. Y. App. filed April 28, 1902. (See page 821.)

757,620. METHOD OF ELECTRIC HEATING; William Smith Horry, Niagara Falls, N. Y. App. filed June 6, 1902. (See page 821.)

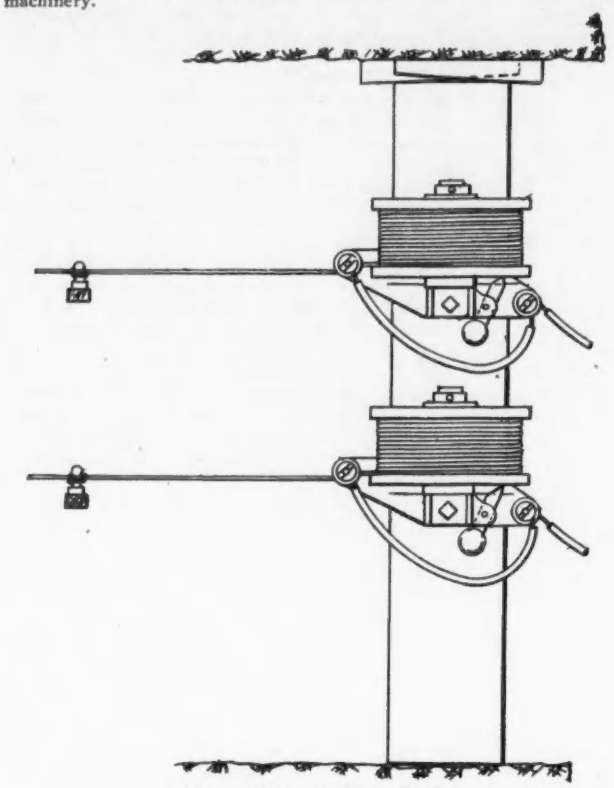
757,621. ELECTRIC FURNACE; William Smith Horry and Edgar F. Price, Niagara Falls, N. Y. App. filed Oct. 11, 1902. (See page 821.)

757,630. SAFETY DEVICE FOR TROLLEY POLES; Phelam McCullough, Thomas Planey and Robert Baron, Liverpool, Eng. App. filed Jan. 22, 1901. Details of a trolley retriever.

757,633. ELECTRIC HEATING; Edgar F. Price, Niagara Falls, N. Y. App. filed April 30, 1903. (See page 821.)

757,634. ELECTRIC RESISTANCE FURNACE; Edgar F. Price, Niagara Falls, N. Y. App. filed April 30, 1903. (See page 821.)

757,636. FLY WHEEL FOR QUICK-RUNNING INTERNAL COMBUSTION ENGINES; Firtz Reichenbach, Charlottenburg, Germany. App. filed June 19, 1903. The fly-wheel is combined with the field magnet of the inductor which furnishes the sparks in the engine cylinder, to reduce weight of the machinery.



756,850.—Electrical Wire Station.

757,637. GAS BATTERY; James H. Reid, Newark, N. J. App. filed Aug. 3, 1903. (See page 821.)

757,659. ELECTRIC ARC LAMP; Robert Hopfelt, Berlin, Germany. App. filed May 13, 1902. The negative carbon is placed above and the positive below, and the electrodes contain certain proportions of metal for lessening the formation of slag.

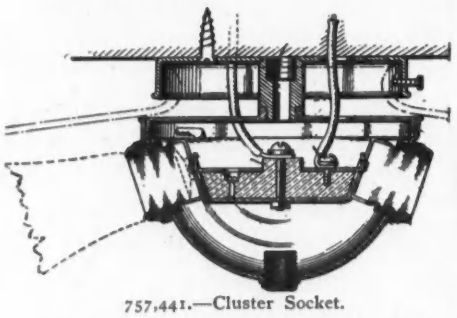
757,670. ELECTRICALLY HEATER SOLDERING IRON; Alfred C. McCloskey, Philadelphia, Pa. App. filed May 6, 1903. Details.

757,687. RHEOSTAT; Imle E. Storey, Amsterdam, N. Y. App. filed Sept. 2, 1903. A plurality of tubular resistance elements, metallic end-pieces connecting them together in series and insulated rods extending through the tube and in contact alternately with end pieces at opposite ends of the tube, whereby connections are made from one side only of the rheostat.

757,692. BLOCK SYSTEM EMERGENCY APPARATUS; Frederick V. Thomson, Phi'adelphia, Pa. App. filed Jan. 10, 1903. Details.

757,695. ELECTRIC LIGHTING AND POWER SYSTEM; William A. Turnbayne, Buffalo, N. Y. App. filed Sept. 29, 1903. An electric motor driving an exciter for a generator driven from a car axle, is so connected up as to ensure a constant e.m.f. at the terminals of the generator.

757,715. PROPULSION OF ELECTRIC AUTOMOBILES; Jonas W. Aylsworth, East Orange, N. J. App. filed June 24, 1903. Both the field and armature are rotative and can be geared to the driving wheels as desired to maintain a uniform relative speed of the parts, notwithstanding changes in the load.



757,441.—Cluster Socket.

757,718. PROCESS OF MAKING STORAGE BATTERY PLATES; Joseph Bijur, New York, N. Y. App. filed Feb. 10, 1903. (See page 821.)

757,722. ELECTRIC SEMAPHORE; Dona Boisvert, Providence, R. I. App. filed Oct. 13, 1902. Details.

757,736. MULTIPLEX TELEGRAPHY; John J. Ghegan, Newark, N. J. App. filed July 3, 1902. A main line, two sets of transmitters and receivers at a number of stations, and means operated by the main line current for switching the corresponding sides of said sets alternately into and out of the main line.

757,765. INSULATOR; John W. Osborne, Winchester, Ill. App. filed Aug. 15, 1903. Details.

757,768. SIGNAL APPARATUS; Jonathan D. Price, Aurora, Ill. App. filed Jan. 21, 1902. Details of the mechanism and apparatus in a railway block signal system.

757,782. ELECTRIC ARC RUPTURING DEVICE; Sidney H. Short, London, Eng. App. filed Feb. 11, 1902. The contact points between which the arc is likely to be formed are placed between the bare poles of an electromagnet, the pole-pieces being insulated from the magnet core, so that the arc in deflecting will not find a path through the magnet core.

757,785. SPRING JACK FOR TELEGRAPH SWITCHBOARDS; John F. Skirrow, East Orange, N. J. App. filed Dec. 16, 1903. The jack is adapted to receive an identification card.

757,786. TROLLEY; Cyrus E. Smith, Fall River, Mass. App. filed Sept. 25, 1903. Details.

757,789. ELEVATOR BRAKE MECHANISM; August Sundh, Yonkers, N. Y. App. filed Aug. 5, 1903. A compound brake mechanism whereby the rotary force of the motor becomes directly applied to the hoisting drums through the previous setting of primary brakes upon a friction disk carried by the rotary motor armature shaft.

757,792. CIRCUIT CONTROLLER FOR INDUCTION COILS; Richard Varley, Providence, R. I. App. filed Jan. 20, 1904. There are two sets of platinum contacts for the vibrator, one of which may be thrown into service when the other becomes defective.

757,799. TELEPHONE TRANSMITTER; Walter L. Wilhelm, Buffalo, N. Y. App. filed Jan. 23, 1902. (See page 822.)

757,802. WAVE RESPONSIVE DEVICE; Albert E. Woodward, Nashua, N. H. App. filed July 9, 1903. The device comprises an aluminum disk in contact on each side with two polished steel balls, all held together by pressure.

757,809. BINDING POST; Stephen C. Houghton, San Francisco, Cal. App. filed Dec. 30, 1903. A pointed screw clamps the wire against an inclined surface.

757,817. PROCESS OF ELECTROLYTICALLY EXTRACTING COPPER AND ZINC FROM ORES; Stanislaw Laszczynski, Kielce, Russia. App. filed Oct. 10, 1902. (See page 821.)

757,824. TROLLEY BASE; Frederick S. Martin, Pittsburg, Pa. App. filed Sept. 4, 1903. A ring-shaped trolley base having a ball bearing upon a ring-shaped platform.

757,826. TELEPHONY; Albert Meinema, Chicago, Ill. App. filed Jan. 16, 1904. (See page 822.)

757,830. MEANS FOR PROTECTING LIVE PARTS OF ELECTRIC SWITCHES OR THE LIKE; William McDevitt, Philadelphia, Pa. App. filed Sept. 26, 1903. The metallic parts are sunken in grooves and cavities in the base.

757,847. ELECTRIC ARC LAMP; Frederik Sindingchristensen, New York, N. Y. App. filed May 4, 1903. Two armatures actuated by a single magnet and respectively controlling the arc-forming and the feeding mechanism.

757,850. ANTISEPTIC ATTACHMENT FOR TELEPHONES; Hugh L. Thompson. App. filed March 1, 1904. (See page 822.)

757, 853. ELECTRIC SWITCH; George H. Whittingham, New York, N. Y. App. filed Oct. 29, 1903. The switch comprises opening and closing devices for supply and armature circuits, that for the supply circuit including a blow-out device, a second blow-out device designed to be included in a brake resistance circuit and means for actuating the blow-out devices alternately.

757,880. ELECTRIC RHEOSTAT; Roy W. Brown, Amsterdam, N. Y. App. filed April 21, 1903. Details.

757,884. THERMAL CUT OUT; Henry P. Clausen, Chicago, Ill. App. filed July 18, 1903. A thin sheet of solder separates two sharp edged members which have a shearing action as soon as the solder becomes slightly softened.

757,898. ELECTRIC CONTROLLER; Arthur C. Eastwood, Cleveland, Ohio. App. filed Jan. 30, 1904. Details.

757,906. ELECTRIC RAILWAY; George H. Fretts, Springfield, Mass. App. filed July 14, 1903. A switch point in the trolley wire can be moved at will by the motorman operating certain electric switches.

757,925. ELECTRIC SWITCH; Charles F. Hopewell, Cambridge, Mass. App. filed Oct. 7, 1903. Details of a tappet switch for trolley wires.

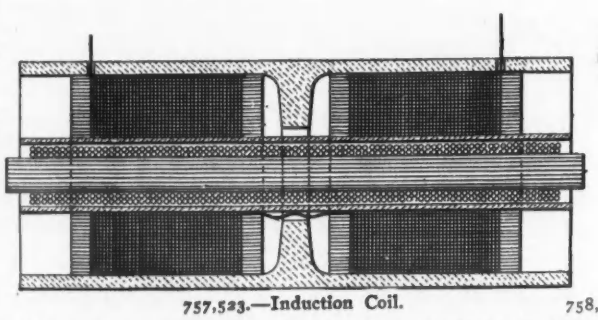
757,942. AUTOMATIC COMMUTATOR; Julien Henri Mercadier, Louvres, France. App. filed Oct. 16, 1903. Details.

757,943. STORAGE BATTERY; Abraham V. Meserole, New York, N. Y. App. filed July 13, 1903. (See page 821.)

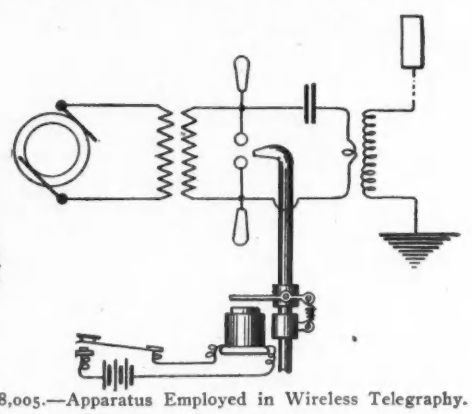
757,958. ELECTRIC ARC LAMP; Isaac W. Percival, St. Louis, Mo. App. filed Jan. 23, 1899. Two sets of carbons placed in one lamp and each designed to take 110 volts in series on a 220-volt circuit.

757,971. THERMAL CUT OUT; Michael Setter, Chicago, Ill. App. filed Aug. 5, 1903. Two telescoping members are held normally apart by a body of solder.

757,972. THERMAL CUT OUT; Michael Setter, Chicago, Ill. App. filed Aug. 5, 1903. Two members normally pulled apart by a spring are held together by solder.



757,523.—Induction Coil.



758,005.—Apparatus Employed in Wireless Telegraphy.

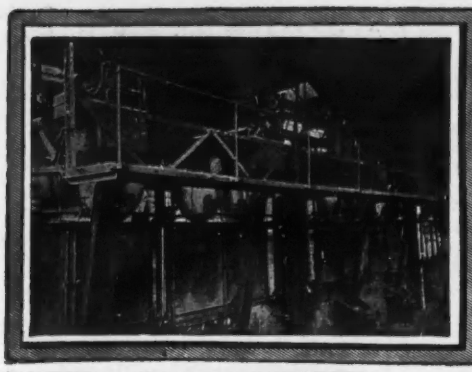
757,991. RECIPROCATING ELECTRIC MOTOR; Adolph F. Christmas, Pittsburg, Pa. App. filed March 16, 1903. Details of a circuit changer.

758,004. DEVICE FOR WIRELESS TELEGRAPHY; John Ambrose Fleming, London, Eng. App. filed April 8, 1901. The signal key is used to vary the current in the primary which is otherwise continuous, the signals being thus effected.

758,005. APPARATUS EMPLOYED IN WIRELESS TELEGRAPHY; John Ambrose Fleming, London, Eng. App. filed Nov. 9, 1901. A constant stream of sparks across the terminals are broken up into signals by intermittent blasts of air.

758,006. WIRELESS TELEGRAPHY; Francis J. Green, Detroit, Mich. App. filed Jan. 9, 1903. An application of wireless telegraphy to railway signaling.

758,031. TELEPHONE DESK SET; Henry P. Clausen, Chicago, Ill. App. filed May 26, 1902. (See page 821.)



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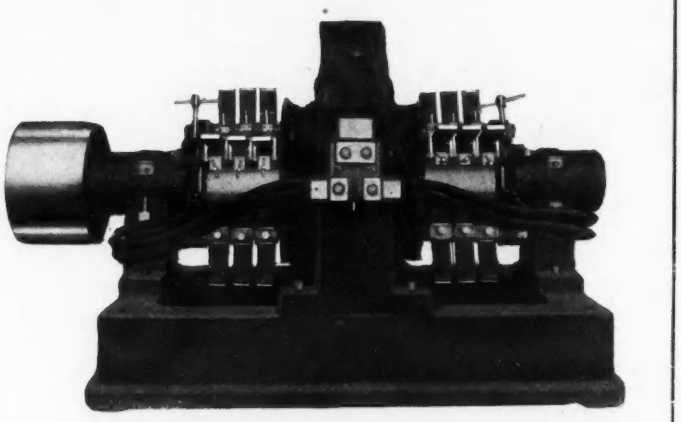

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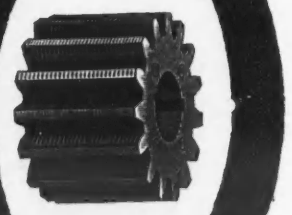

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The rate for "Position Wanted" advertisements of forty words or less is one dollar an insertion; additional words two cents each, payable in advance. Remittance and copy should reach this office not later than Tuesday morning for the next succeeding issue.

POSITION WANTED.—By chief electrical engineer of company manufacturing dynamos and motors (direct current) from 1 to 500-K.W; desires to change location; successful designing experience, having been engaged in electrical business for past 11 years; age 33 years; married; splendid recommendations from present employers. Address No. 1414, care Electrical World and Engineer, New York.

POSITION WANTED.—By an American electrical engineer at present in South America under contract with an American company to report on electrical properties; desires similar or other commissions before returning; facilities and qualifications unequaled. Address C. W. C., 52 West 53d St., New York City.

POSITION WANTED.—As superintendent or superintendent's assistant on construction work; college education; experience as foreman for inside and outside construction for light and power, high and low tension, as well as designing sub-stations; speaks four languages; will go anywhere; at present in charge of the electric construction for a mine and mining town. Address No. 1424, care Electrical World and Engineer, New York.

POSITION WANTED.—By man of experience in incandescent lamp manufacture; being employed as assistant superintendent of lamp factory he is perfectly familiar with the work of each department; is thoroughly experienced in making, treating and calculating sizes of filaments to suit the various lamps and is well posted in each of the other operations. Address No. 1442, care Electrical World and Engineer, New York.

POSITION WANTED.—With lighting and power company to locate trouble or take charge meter department by a technical graduate, 28; four years testing, alternating and direct current motors, generators, watt-hour meters and other devices; A1 record with General Electric and Westinghouse Companies; also three years' practical experience on steam side; no license. Address No. 1429, care Electrical World and Engineer, New York.

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It will put that high gloss on the commutator you have so long sought.

For Sale by all Supply Houses.

SAMPLE STICK SENT FREE

K. McLENNAN & CO.

Sole Manufacturers (3)

100 WASHINGTON ST. CHICAGO, ILL.

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They bring business to the user.
They increase the opportunities for supply dealers, contractors and central station men to do business.
They increase the number of current users.
The REYNOLDS FLASHER is a proven success.

REYNOLDS ELECTRIC FLASHER MFG. CO.
221-225 FIFTH AVENUE, CHICAGO, ILL.

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POSITION WANTED.—By first-class electrical engineer, grade 85, United States Civil Service; experienced in high voltage water power and steam plants; also experienced in mine, smelter, stamp mill and factory work; best of references from all parts of United States; will go any place. Address No. 1443, care Electrical World and Engineer, New York.

POSITION WANTED.—As auditor or purchasing agent; 12 years' experience in electric light, gas and street railroads; fully experienced in construction, office methods and latest methods of accounting. Address No. 1454, care Electrical World and Engineer, New York.

POSITION WANTED.—With electrical engineering, contracting or supply company, or as assistant in isolated electrical plant by graduate International Correspondence School, advanced student electrical engineering American School of Correspondence; age 27; electrical and business experience. New York or vicinity preferred. Address No. 1455, care Electrical World and Engineer, New York.

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POSITION WANTED.—By experienced young man, college graduate, desires position as manager or superintendent of lighting or power plant of small town. Married, aged 32. Long business experience. Will make your plant pay. Free after July 15. Address No. 1453, care Electrical World and Engineer, New York.

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(Continued on page 51.)

LATEST TYPES OF (second-hand) ELECTRICAL MACHINERY

FOR SALE AT BARGAIN PRICES

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing complete list of apparatus with NET PRICES. All machines fully guaranteed.

ALTERNATORS—60 CYCLES
1100 or 2200 Volts.

Lt.		
2	300	Gen. Elec., 15-K.W., comp., single phase.
1	500	Wood, 25-K.W., comp., single phase
1	600	West., 30-K.W., comp., single phase
1	750	Wood, 37½-K.W., comp., single phase
1	900	West., 45-K.W., comp., 2 phase.
1	1200	West., 60-K.W., single ph., comp.
1	1500	Warren-Medberry, 75-K.W., 2 ph., ind. type
1	1500	Stan., inductor, 75-K.W., 2 ph.
1	1500	West, 75-K.W., comp., distributed winding, 2 ph.
1	1500	West., 75-K.W., 2 ph., 2200 v., d. c. to 14x14 Gates 4-valve aut. engine
1	1500	Wood, 75-K.W., comp.
1	2400	Gen. Elec., 120-K.W., 3 phase, 2200 or 3300 v.
1	7200	Gen. Elec., 360-K.W., 3 phase, 2300 volts
1	3000	Westinghouse, single phase, 150-K.W., 2200 volts, latest type, direct connected to 12x24x14 Harrisburg tandem compound self-oiling engine, complete with exciter and switchboard panel, speed 257

ALTERNATORS—125-133 CYCLES.

Lt.		
1	650	Wood, 33-K.W., comp.
1	750	West., 37½-K.W.
1	750	Wood, 37½-K.W., comp.
1	900	Warren-Medberry, 45-K.W., inductor type
1	1000	Wood, 50-K.W., comp.
2	1200	West., 60-K.W., toothed armt., comp.
1	1500	Wood, 75-K.W., comp.
1	1500	Stanley, inductor type, 75-K.W., 1100 or 2200 v., 2 phase.
1	2400	Gen. Elec., 120-K.W., type A 120, latest type, comp., toothed armt.
2	2400	Gen. Elec., 120-K.W., type A S, comp., slotted armt.
2	2400	West., 120-K.W., comp., self-oiler, toothed armt.
2	3000	Stanley inductor type, 150-K.W., 1100 or 2200 v., 2 phase.
1	8000	West., 400-K.W., slotted armt., 3 bearings, distributed windings

110 TO 125 VOLT GENERATORS.
DIRECT CURRENT.

Lt.			Speed.
6	10	Towle, M. P., compound	2000
2	12	Edison, self-oiler	2700
2	130	Gen. Elec., M. P., 6 pole shunt, direct connected to Ames tandem comp. 11x17x12 automatic engine	270
2	1800	Edison, 100-K.W., s-o., comp.	650
1	1800	Western Electric, M. P., comp., 6 pole, 100-K.W.	425
1	2200	Western Electric, M. P., 125-K.W., latest type, comp., 6 pole, 3 bearing. (Above machine can be arranged for direct connection also.)	225
2	2500	Western Electric, M. P., comp., 150-K.W., direct connected to 16x18 McEwen engine	240

Lt.			Speed.
1	15	Wagner, 15 amp., M.P. 50 v.	1800
1	30	General Electric, type C A	2100
2	35	Hobart, M. P., comp.	1600
1	40	Roth, M. P., comp., direct connected to Drake engine	800
1	45	Lundell	1800
3	45	Westinghouse, M. P., comp	1800
1	50	Crocker-Wheeler, self-oiler	1150
2	50	Northern, M. P., compound	2050
1	50	Westinghouse, M. P., comp.	1150
2	60	Hobart, M. P., comp., s-o.	1200
1	75	Westinghouse, M. P., comp.	1600
1	75	Phoenix, comp., direct connected to No. 4 Case engine	650
1	80	Fort Wayne, multipolar	1600
1	80	Crocker-Wheeler	1000
1	80	Riker, M. P., comp., s-o.	1100
1	80	Perrett, multipolar	950
1	100	Triumph, M. P., comp.	1250
1	100	Card, M. P.	1000
2	110	Commercial, M. P., comp.	1600
1	150	Edison, comp.	1700
1	150	Eddy, M. P.	1650
1	150	Western Elec., M. P.	1600
1	150	General Electric, M. P.	1400
1	160	Triumph, M. P., compound	1200
1	160	Northern, M. P., compound	900
1	165	Am. Engine Co., M. P.	1400
1	210	Edison, self-oiler, 12-K.W.	1600
1	210	Phoenix, M. P., comp.	1650
1	210	Eddy, M. P.	1100
1	225	Card, M. P., comp.	690
1	260	Commercial, M. P., comp.	1100
1	300	Phoenix, M. P.	1100
1	300	Perrett, M. P., comp.	750
1	300	Ahlms-Edwards, M. P., comp.	825
2	300	Gen. Electric, M. P., comp.	1100
1	300	Western Elec., M. P., comp.	750
2	350	Edison, 20-K.W., comp., s-o.	1400
2	350	C. & C., M. P.	800
1	350	Card, M. P., enclosed	800
1	400	Northern, 22½-K.W., M. P., comp.	1000

Lt.			Speed.
1	400	Crocker-Wheeler, M.P, comp.	875
2	400	Westinghouse, M. P., comp.	975
2	450	Edison, 25-K.W., self-oiler	1300
2	450	Commercial, M. P., comp.	1000
1	450	Quaker City, M. P., comp.	1000
1	450	Triumph, M. P., comp.	750
2	450	Sprague-Lundell, M. P., comp	875
1	450	Eddy, M. P., comp.	950
1	450	Gen. Electric, M. P., comp.	1050
1	450	Western Elec., M. P., comp.	650
1	540	Edison, comp., 30-K.W.	1200
1	540	C. & C., M. P., 30-K.W.	700
1	540	Elwell-Parker, M. P., comp.	600
2	540	Gen. Elec., M. P., comp. 30-K.W.	1000
3	600	Card, M. P., compound	750
1	650	Milwaukee, M. P., comp.	650
1	650	Westinghouse, M. P., comp.	900
1	650	Westinghouse, M. P., 35-K.W., engine type, direct connected to 10x10 enclosed self-oiling Buffalo Forge engine, class A, upright	350
2	700	Commercial, M. P., comp.	865
1	700	Card, M. P., compound	750
1	700	Crocker-Wheeler, M. P., comp.	1085
1	900	Wagner, M. P., comp., 50-K.W.	950
1	1000	Edison, s-o., 60-K.W., comp.	700
1	1000	Gen. Elec., 6 pole, comp., direct connected to 12x13 Weston automatic engine, 60-K.W.	275
1	1100	Triumph, M. P., comp., 65-K.W.	850
1	1300	Card, M. P., comp., 75-K.W.	500
1	1350	Waddel-Entz, 80-K.W., d. c. to Armington & Sims 15½x14 engine	265
1	1350	Ft. Wayne, comp., direct connected to 13x14 Buckeye vertical engine, 80-K.W.	275

220 TO 250 VOLT GENERATORS.

K.W.			Speed.
1	7½	Holtzer-Cabot, compound	1350
1	9	New England, M. P.	1600
2	10	T.-H., D 10, oil cups	1600
1	12	Western Elec., M. P., comp.	750
1	15	Edison, self-oiler	1500
1	17½	Kester, comp.	1350
1	17½	Eddy, type C, comp.	1450
1	20	Edison, self-oiler, comp.	1400
1	20	Western Electric, comp., s-o.	700
1	20	Keystone, M. P., comp.	950
1	20	Eddy, M. P., comp.	825
1	20	Western Elec., M. P., comp.	650
2	30	C. & C., comp., self-oilers	800
1	40	C. & C., multipolar, comp.	750
1	40	Eddy, M. P., comp.	875
1	40	Commercial, M. P., d. c. to 11x12 automatic Chandler-Taylor engine	300
1	45	Edison, comp., self-oiler	1000
1	45	Am. Engine Co., M. P., comp.	700
1	45	Western Elec., M. P., comp.	550
1	45	C. & C., M. P., comp.	700
1	45	Gen. Elec., M. P., comp.	925
1	50	C. & C., compound	800
1	50	Commercial, M. P., comp.	775
1	50	Maine, M. P., compound	600
1	55	Fuller, multipolar, comp.	750
1	55	Eddy, M. P., comp.	750
1	60	Sprague, compound	500
1	60	Northern, M. P., comp.	800
1	75	Siemens & Halske, Churchward type, M. P., direct connected to 14x14 Ideal engine	300
1	80	C. & C., comp., self-oiler	625
1	100	Edison, comp., self-oiler	650
1	100	Commercial, M. P., comp.	675
1	125	Eddy, M. P., comp.	700
2	150	National, M. P., comp.	350
1	200	Eddy, multipolar, compound	500
1	250	Western Electric, 6 pole, type L, 3 bearing, compound	450
1	300	Western Electric, M. P., brand new	480

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that ELECTRICAL WORLD AND ENGINEER has the largest circulation of any electrical weekly journal published, and we also know it to be the best. Compare any issue of it with the corresponding issue of any other electrical paper and

Judge for Yourself!

MODERN ELECTRICAL MACHINERY FOR SALE.

DIRECT CONNECTED UNIT, 220 Volts

50-K.W. American Ball Dynamo & Engine.

110 VOLTS DIRECT CURRENT
Dynamos or Motors

30-K.W. Bullock, M. P.
15-K.W. Eddy, M. P.
10-K.W. Eddy, M. P.
5-K.W. C. & C.
3-K.W. C. & C.
2-K.W. Lundell.
1-K.W. C. & C.

500 VOLTS DIRECT CURRENT
Dynamos or Motors

15-H.P. General Elec., M. P.
7½-H.P. General Elec., M. P.
5-H.P. Sprague.
2-H.P. General Elec.

220 VOLTS DIRECT CURRENT
Dynamos or Motors

40-H.P. Sprague, M. P.
25-H.P. Crocker-Wheeler, M. P.
20-H.P. Card.
15-H.P. Sprague, M. P.
10-H.P. General Elec.
10-H.P. Holtzer Cabot.
7½-H.P. Card.
7½-H.P. Edison.
7½-H.P. C. & C.
5-H.P. Paragon, M. P.
5-H.P. Holtzer Cabot.
5-H.P. Crocker-Wheeler.
3-H.P. Diehl.
3-H.P. C. & C.
2-H.P. General Elec.
2-H.P. Diehl.
1½-H.P. C. & C.
1-H.P. Crocker-Wheeler.

ALTERNATING INDUCTION MOTORS

2 Phase, 60 Cycles, 220 Volts

30-H.P. Type F Westinghouse.
15-H.P. Type C Westinghouse.
10-H.P. Type C Westinghouse.
7½-H.P. Type C Westinghouse.
5-H.P. Type C Westinghouse.
2-H.P. General Elec.
1-H.P. Westinghouse.
½-H.P. General Elec., 220 or 110 v.
¼-H.P. General Elec.

2 Phase, 440 Volts, 60 Cycles

30-H.P. Westinghouse.
15-H.P. Westinghouse.
10-H.P. Westinghouse.
7½-H.P. Westinghouse.
5-H.P. Westinghouse.
3-H.P. Westinghouse.
1-H.P. Westinghouse.

3 Phase, 60 Cycles

5-H.P. Westinghouse, 220 volts.
2-H.P. Gen. Elec., 110 volts.
2-H.P. Westinghouse, 220 volts.
½-H.P. General Elec., 220 volts.
½-H.P. General Elec., 110 volts.

1 Phase, 60 Cycles

7-H.P. Wagner, latest type.
½-H.P. General Elec.
¼-H.P. General Elec.

1 Phase, 125 Cycles

3-H.P. Wagner, latest type.
1-H.P. General Elec.
½-H.P. Emerson.
1/10-H.P. Emerson.

Large stock of small motors, auto-starters, starting boxes, rheostats, switchboards, voltmeters, ammeters, etc.

I BUY, RENT AND INSTALL.—GEORGE BENDER, 137 CENTRE STREET, NEW YORK.

ELECTRIC LOCOMOTIVES.

	Ton.	
1	10	Morgan-Gardner, type M, 250 v., direct current, double motor locomotive, 74-K.W., 42-inch gauge, speed 6 to 10 miles per hour
1	17	Morgan-Gardner, type N, 250 v., direct current, double motor locomotive, 115-K.W., 40-in. gauge, speed 8 miles per hour

500 TO 550 VOLT GENERATORS.

	K.W.		Speed.
1	60	Edison, comp., self-oiler, new armt. and commutator	800
1	62	T.-H., D 62, s-o., comp.	900
1	75	Akron, M. P., 6 pole	900
1	75	Bullock, multipolar	900
2	75	General Electric, M. P. 4, comp., new rewound	700
1	100	Siemens & Halske, 4 pole, with bar-wound armature, compound	600
2	100	Edison, compound	650
1	100	Gen. Elec., M. P. 4, comp.	650
1		General Electric slate panel switchboard for above, complete with ammeter, circuit breaker and resetting device, main line switch, rheostat switch, bus-bar connections, etc.	
2	120	Westinghouse, M. P., comp.	625
1	200	Thompson-Ryan, M. P., comp., three bearings	525
1	200	General Electric, M. P. 4, comp., s-o., 3 bearings, new commutator	400

ARC DYNAMOS.

	Lt.	C.P.		Speed.
1	35	2000	T.-H., L D 2 ball	820
1	45	1200	Brush, No. 7	1050
1	50	1200	T.-H., L D 12, new ball	820
2	50	2000	T.-H., M. D 2, s-o., ring	820
1	65	2000	Brush, No. 8	950
1	75	1200	T.-H., M D 12, s-o.,	820
1	75	1200	Wood	950
1	100	2000	Wood	600
1	125	1200	Brush, 6.6 amp.	700
2	125	2000	Brush, 9.6 amp.	500
1	125	1200	Excelsior	700

220 TO 250 VOLT MOTORS.

	H.P.	DIRECT CURRENT.	Speed.
1	1	General Electric, type I B	1025
1	1½	Commercial, self-oiler	1200
1	2	Lundell, newly rewound	1000
1	2½	Riker, s-o., with extra armt.	1460
1	3	C. & C.	1400
1	3	Bernard, M. P.	1525
1	3	Gibbs, M. P.	1400
1	3	Lundell, self-oiler	1500
2	1	General Electric, 110 volts	1800
3	3	Western Electric, M. P.	1000
3	3	Westinghouse, M. P.	1700
1	3	Storey, variable speed	300-1500
1	3½	Eddy, M. P.	400
1	4	Commercial, M. P.	450
2	5	Gibbs, M. P.	1400
3	5	Hobart, M. P.	1050
5	5	Western Electric, M. P.	950
1	5	Eddy, M. P.	300
3	5	Belknap, M. P.	230
2	5	Crocker-Wheeler special printing press motors, direct con.	318
1	6½	Jenny, M. P., back geared, speed of shaft	440
1	7½	Waddell-Entz, M. P.	900
1	7½	Edison	1350
1	7½	Towle, M. P.	1600
1	7½	Western Electric, M. P.	1150
2	7½	Western Electric, M. P.	950
1	7½	Milwaukee, M. P., series, crane type, grease cup	600
1	8	Holtzer-Cabot	1250
1	8	Crocker-Wheeler, series, crane type	900
1	8	Maine, M. P.	200
1	10	Standard, M. P.	670
1	10	C. & C., M. P., enclosed	1100
1	10	Keystone, M. P., enclosed	1175
1	10	Western Electric, M. P.	800
1	10	Story, M. P., enclosed	600
2	10	Westinghouse, M. P.	1250
3	10	Bernard, M. P.	130
1	12	C. & C., self-oiler	1100
1	15	Keystone, M. P.	1570
1	15	New England, M. P., 8 pole	650
1	15	Western Electric, M. P	625
1	18	Edison, 15 K.W.	1150
1	20	Eddy	1300
1	20	Kester	1250
2	25	Edison, self-oilers	1100
1	25	Western Electric	525
1	25	Keystone, M. P.	850

BARGAINS IN (second-hand) ELECTRICAL MACHINERY

We do not offer old, worn out machines fit for the Junk pile, but the LATEST TYPES of the leading manufacturers.

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing NET prices—all machines fully guaranteed.

	H.P.		Speed.
1	25	Eddy, M. P.	725
1	25	Western Electric, M. P.	550
2	40	C. & C., self-oilers	650
2	40	Sprague-Lundell, M. P.	625
1	50	C. & C. multipolar	650
1	50	Eddy, M. P.	675
1	50	Am. Engine Co., M. P.	565
1	60	C. & C., self-oiler	600
1	60	Edison, self-oiler	750
1	60	Commercial, M. P.	600
1	60	C. & C., M. P.	560
1	60	Maine, M. P.	500
1	60	Western Electric, M. P.	425
1	60	General Electric, M. P.	800
1	65	Eddy, M. P.	650
1	70	Fuller, multipolar	600
1	75	Sprague, self-oiler	450
1	75	Northern, M. P.	700
1	85	Western Electric, self-oiler	500
1	100	C. & C., self-oiler	450
1	125	Edison, self-oiler	550
1	135	Commercial, M. P.	675
1	150	Eddy, M. P.	600
2	200	National, M. P.	300

500 TO 550 VOLT MOTORS.

	H.P.		Speed.
1	1	General Electric, C. A.	1200
1	1½	Belknap, self-oiler	1700
2	1½	Northern, series	1400
2	1½	Crocker-Wheeler	1550
1	2	Maine, M. P.	1100
1	2½	Bain, self-oiler	2100
1	2½	New England	1500
1	3	C. & C., self-oiler	1600
1	3	General Electric, type C E	1800
1	3	Maine, M. P.	1100
1	3	Jenny, M. P., back geared, speed of shaft	240
1	3½	Roth	1700
1	3½	Roth, M. P.	950
1	3½	Westinghouse, M. P.	1050
1	4	Edison, 3 K.W.	1700
4	4	Maine, multipolar	550
1	4	Bernard, M. P.	550
1	5	Hobart, self-oiler	1600
1	5	Fort Wayne	1400
2	5	Triumph, M. P.	1250
3	5	Crocker-Wheeler	950
1	6	C. & C., enclosed	1030
2	6	T.-H., D 5, self-oilers	1800
2	7½	Thomson-Houston, D 7½	1600
1	7½	Roth, self-oiler	1400
1	7½	Card, multipolar	775
1	7½	Jenney, M. P.	1500
1	7½	C. & C., M. P., compound	1160
3	7½	Crocker-Wheeler	1500
1	7½	Eddy, M. P.	875
1	10	Phoenix, M. P.	950
1	10	Crocker-Wheeler	1275
1	10	Northern, M. P.	1350
1	10	Triumph, M. P.	1100
2	10	General Electric, M. P.	1400
1	10	Perrett, M. P., compound	600
1	10	Eddy, M. P.	650
3	10	Belknap, M. P.	500
1	12	Am. Engine Co., M. P.	1365
1	15	Eddy, self-oiler	1725
1	15	C. & C., self-oiler	975
1	15	Edison	1275
1	15	Perrett, M. P.	1100
1	15	Maine, M. P.	450
1	20	Eddy, self-oiler	1500
1	20	Perrett, M. P.	700
1	20	Holtzer-Cabot, M.P., enclosed	1150

ALTERNATING CURRENT MOTORS.

SINGLE PHASE. 125-133 CYCLES.

	H.P.		Speed.
10	½	Stanley, 100-110 volts, new	2400
1	½	Holtzer-Cabot, 104 volts	2500
1	½	Emerson, 104 volts	2000
1	½	Wagner, 104 volts, aut.	2000
1	1	Fort Wayne, 104 volts	2500
1	1	Wagner, 208 volts, aut.	2000
1	1½	Wagner, 208 volts, aut.	2000
1	3½	Wagner, 110 volts, automatic	1875

THREE PHASE. 125-133 CYCLES.
For Monocyclic System.

	H.P.		Speed.
1	3	General Electric, 110 volts	1875

SINGLE PHASE. 60 CYCLES.

	H.P.		Speed.
2	¼	Phillips, 104 volts	1800
1	½	General Electric, type I S, 110 v., with type K. S. condenser-compensator, new	1800
1	¾	Gen. Elec., type I. S., form L	1800
1	1	Phillips, 208 volts	1600
1	1	Phillips, 104 volts	1600
1	2	Wagner, 500 volts, aut.	1800
1	2	Wagner, 104 volts	1800
1	15	Wagner, 104 volts, aut.	1200
2	30	Wagner, 104 volts, automatic	1200

FOR SALE.

DIRECT CONNECTED.

30-K.W. Eddy dynamo to Watertown engine, 110 volts.
10-K.W. Westinghouse dynamo to Armington & Sims engine, 110 volts.
10-K.W. Westinghouse dynamo to Westinghouse engine, 110 volts.
80-Amp. Edison dynamo to Brotherhood engine, 80 volts.
20-H.P. Elektron 220 volt motor to Morse Williams freight elevator.

BELTED.

60-amp. Crocker-Wheeler to Herresoff engine, 110 volts.
2000 volt Electro Dynamic arc dynamo, 10 amperes.
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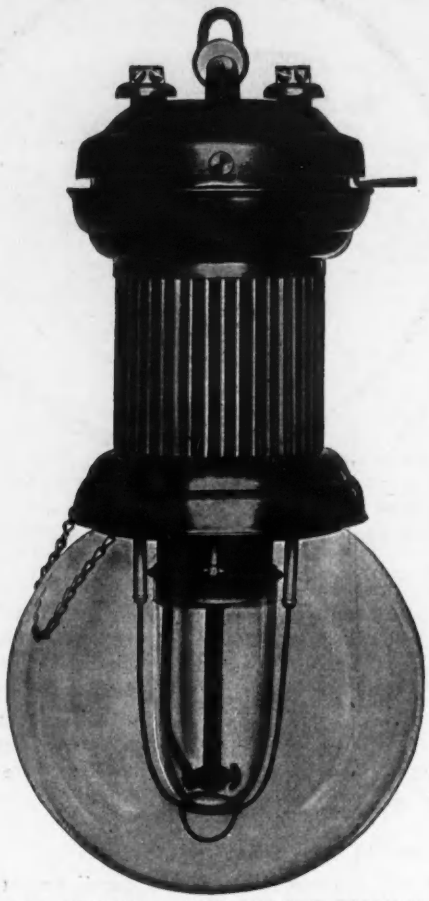

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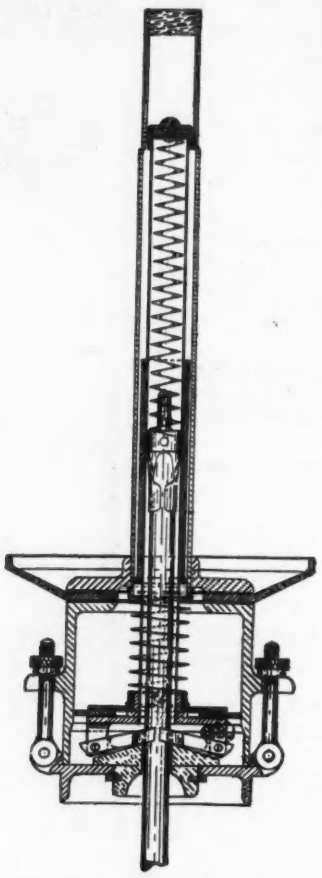

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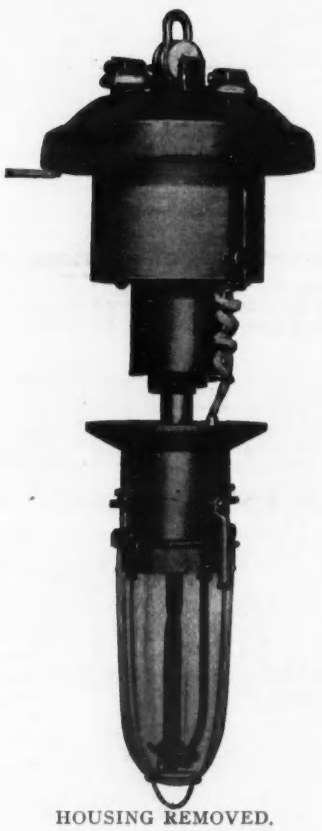

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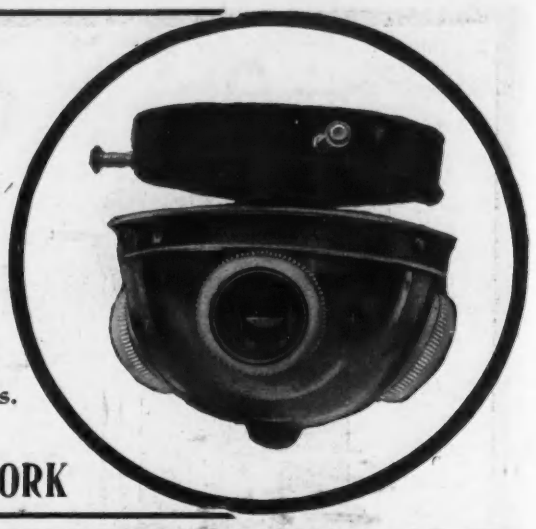

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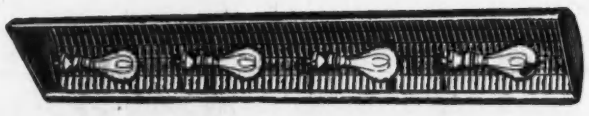

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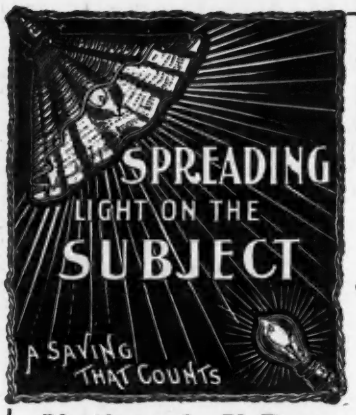

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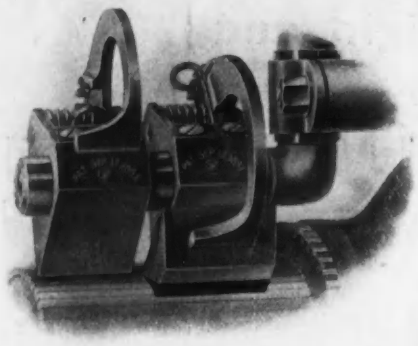

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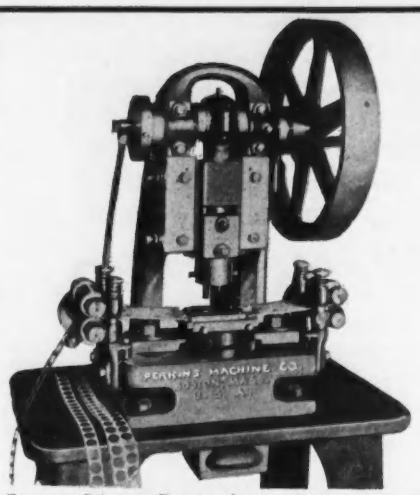

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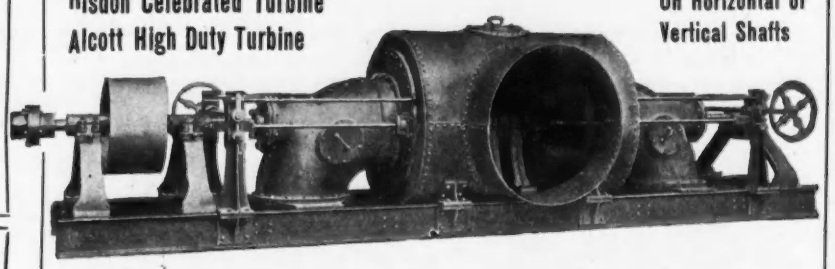

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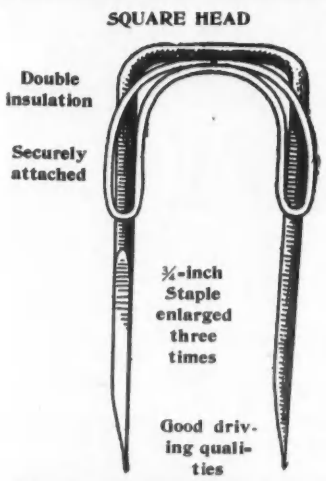

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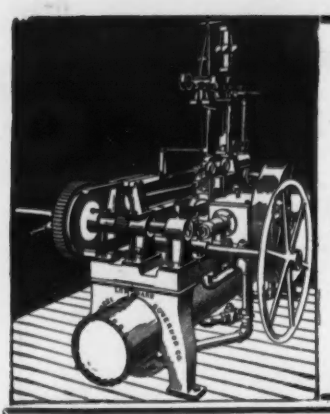

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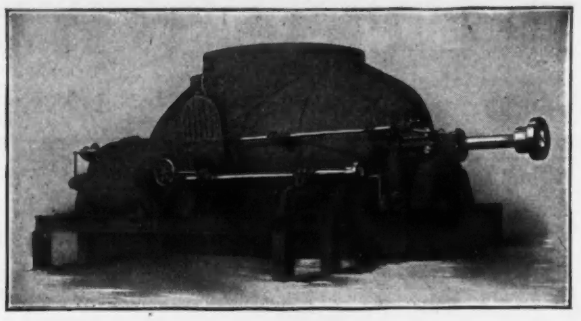

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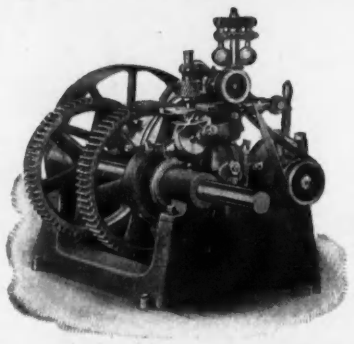

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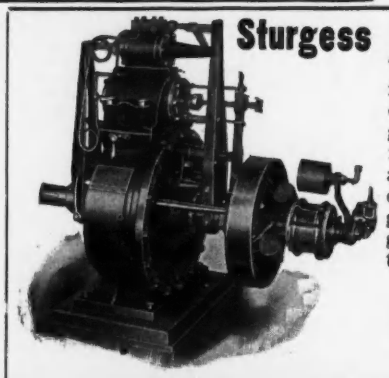

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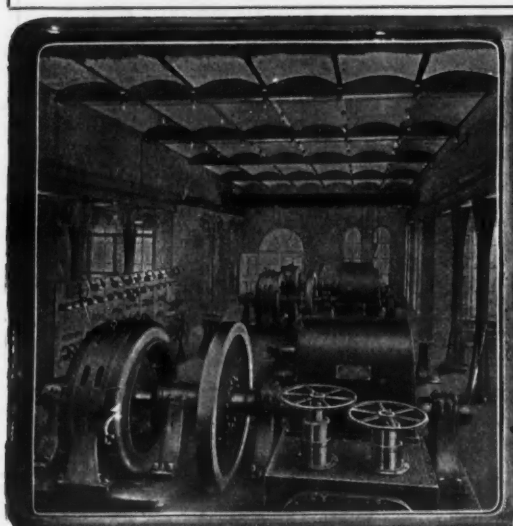

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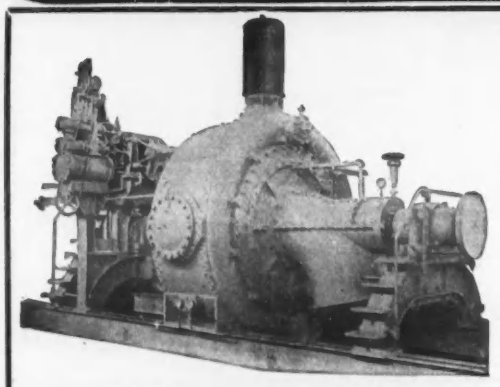

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The illustration shows the large NIAGARA design, HORIZONTAL SHAFT TURBINES recently installed by us, for the NIAGARA FALLS HYDRAULIC POWER & MFG. CO., Niagara Falls, N. Y. Tests conducted by competent engineers developed as follows:

Head.	Gateage.	Speed.	H.P.	Generator Effcy.	Turbine Effcy.
213 ft.	½	257 r.p.m.	1750	95%	.730%
213 "	¾	257 "	3000	95%	.856%
213 "	Full	257 "	3500	95%	.815%

These results have never been equalled by any turbine of the Horizontal Shaft Design, operating under equally HIGH HEADS. The test was made AFTER TURBINES WERE INSTALLED, direct coupled to Generators. Francis' weirs and formulæ for discharge were used. The original test reports on file at our offices. These turbines are all fitted with our SAMSON BALANCED GATES. Note especially the UNIFORM SPEED at ALL GATEAGES.

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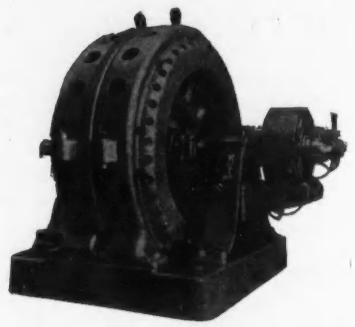

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Our alternating current generators are built for either rope or belt drive, or for direct coupling with such prime movers as steam engines, gas engines, water wheels, etc.

They have a very large overload capacity, and their solid field poles insure absolute parallel operation under the most trying conditions.

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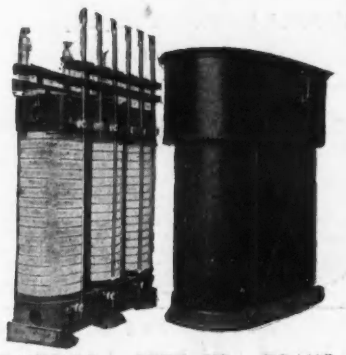
They are well known for their absolute reliability during continuous service. Their efficiency and regulation are of the most perfect on inductive and non-inductive load, and above all, special attention is paid to provide extra safe insulation.



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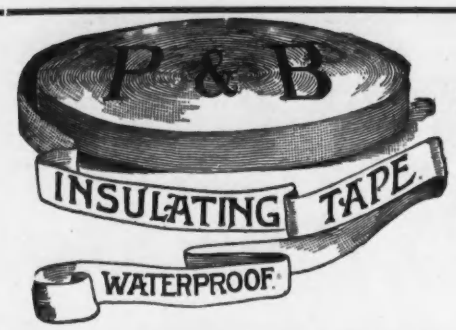

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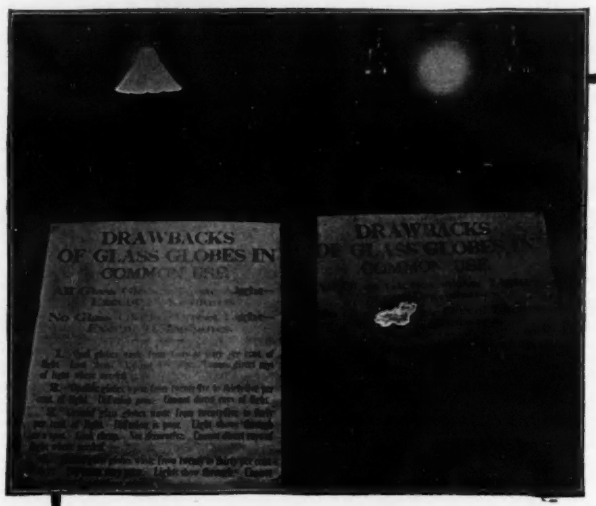

This illustration is from an untouched photograph.

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